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CORALS FROM THE TITHONIAN CARBONATE COMPLEX IN THE DĄBROWA TARNOWSKA–SZCZUCIN AREA (POLISH CARPATHIAN FORELAND)

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Abstract: The studied corals have been collected from cores of boreholes located in the central part of the Polish Carpathian Foreland in the Dąbrowa Tarnowska–Szczucin area. The Jurassic complex in this area presents a continuous stratigraphic section from the Upper Callovian to Tithonian, locally passing to the Lower Cretaceous (Berriasian). Its thickness exceeds 1,100 m in this area. This complex is composed of marine, mainly shallow-water deposits. The corals occur within the upper part of the Upper Jurassic (Tithonian) deposits, almost entirely within the Swarzów Limestone Formation (= coral-algal limestone formation). This occurrence marks the northernmost extent of Tithonian shallow-water corals in Poland and one of the northernmost in Europe. 42 coral species (among them 14 in open nomenclature) were identified in deposits of this formation. They include two new species: *Complexastrea magna* and *Complexastrea dabroviensis*. All taxa, except one, belong to the order Scleractinia. The described assemblage displays a Late Jurassic character. The broader stratigraphic span is assigned to some species, which are quoted from the Middle Jurassic and some species lasted until the Early Cretaceous, Berriasian and/or Valanginian.

Key words: Scleractinian corals, carbonate platform, Tithonian, Carpathian Foreland, Poland.

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INTRODUCTION

Numerous papers (Morycowa, 1971, 1976, 1985; Morycowa & Moryc, 1976; Golonka, 1978; Urbaniec & Świetlik, 2003; Król, 2004; Matyja & Barski, 2007; Matyja, 2009) noticed the occurrence of the Late Jurassic scleractinian corals in the boreholes from the Carpathian Foreland, and described lithological characteristics of coral-bearing deposits. This fauna has not been determined taxonomically. Only few determined coral specimens were contained in the broad synthesis of the Upper Jurassic microfacies (Morycowa & Moryc, 1976).

It is noteworthy that the occurrence of Tithonian shallow-water corals from the studied region marks their northernmost extent in Poland and one of the northernmost in Europe.

The recently investigated corals come from eight boreholes from the Dąbrowa Tarnowska–Szczucin area (Swarzów 3, 4, 8, 10, Dąbrowa Tarnowska l, 4, Smęgorzów 2 and Dąbrówki Breńskie 1; Fig. 1). The substantial section of the Upper Jurassic deposits, more than 1,100 m thick, was drilled in this area (Morycowa & Moryc, 1976). This complex contains entirely carbonate deposits encompassing the latest Middle Jurassic (Late Callovian) to Tithonian inclusively. Probably, also younger deposits (Berriasian) occur in the uppermost part of the carbonate section; they are not, however, sufficiently biostratigraphically documented in this region (Matyja, 2009; Morycowa & Moryc, 1911). The shallow-water Scleractinian corals are derived from the upper part of the Upper Jurassic deposits, almost entirely from the Swarzów Limestone Formation (= coral-algal limestone formation). The thickness of this formation in the study area is around 140–180 m (Morycowa & Moryc, 1976). The Tithonian age of this formation was assumed on the basis of organic cysts of dinoflagellates (Matyja & Barski, 2007; Barski & Matyja, 2008; Matyja, 2009) and calpionellids (Morycowa & Moryc, 2011). The described coral species belong to 26 genera, 11 families, 6 suborders and 2 orders. The coral assemblage displays a Late Jurassic character. It contains species common in the Middle Oxfordian–Kimmeridgian faunas from the Peri-Tethyan and Tethyan deposits in Europe and Western Asia, as well as from the Tithonian; some species lasted until the Early Cretaceous, Berriasian and/or Valanginian of the European Tethyan facies (*cf.* Morycowa, 1968; Eliášová, 1990; Roniewicz, 2008). The broader stratigraphic span is assigned to some species, which are quoted from the Middle Jurassic (*cf.* Pandey & Fürsich, 2003, 2006).

MATERIAL AND METHODS

The investigated coral fauna contains about 70 specimens, from which about 140 thin sections were made in the Institute of Geological Sciences, Jagiellonian University in Kraków. These investigations were carried out with the help of binocular and petrographic microscopes.

The specimens described below are housed in the Museum of the Institute of Geological Sciences, Jagiellonian University, Kraków (coll. E. Morycowa, acronym: UJ 217P). The respective samples with corals were marked by subsequent numbers (1, 2, ...), and some samples added at a later time were marked accordingly by numbers (2A, 5A, 5B). The thin sections were marked by specimen numbers and successive alphabet letters (*e.g.*, la, 1b…). In cases, when more than one taxon is present in the given sample, the samples are marked as 2/1, 2/2, ... while thin sections as 2/la, 2/2a, *etc.*

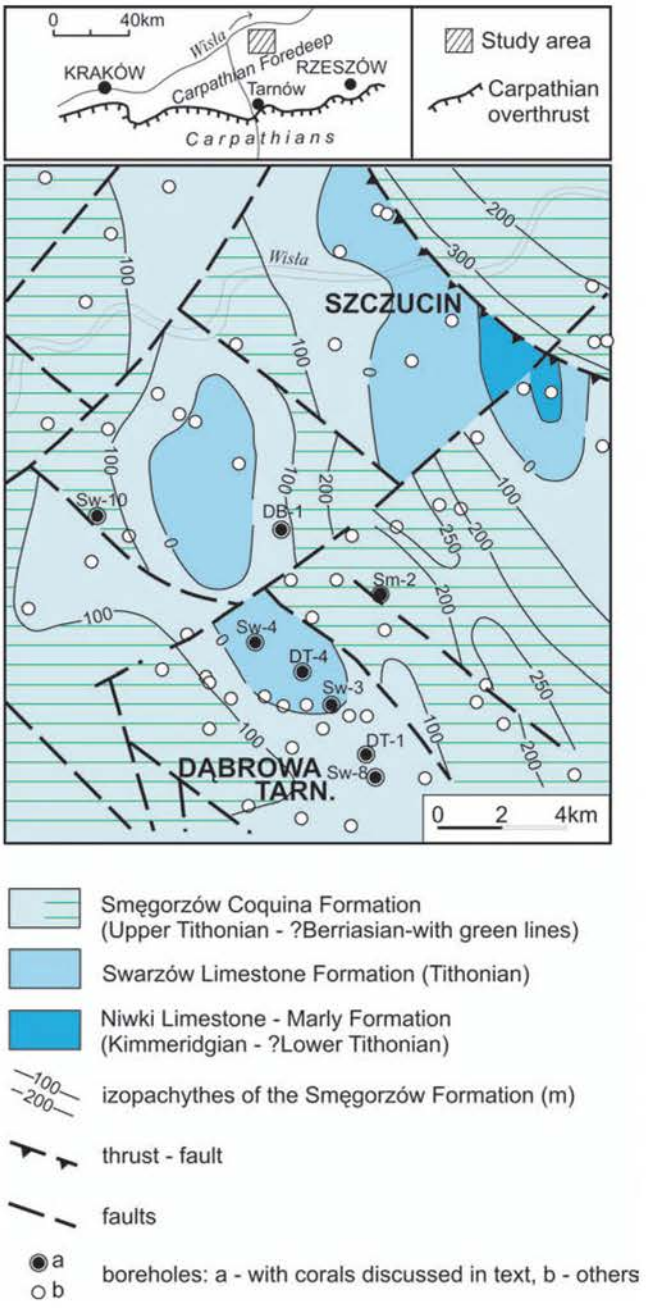

Fig. 1. A – Location of the study area. **B** – Geological map of the sub-Miocene and sub-Upper Cretaceous erosional surface in the Dąbrowa Tarnowska–Szczucin area (after Morycowa & Moryc, 2011; simplified). Boreholes with studied corals: DB-1 – Dąbrówki Breńskie 1; DT-1, 4 – Dąbrowa Tarnowska 1, 4; Sm-2 – Smęgorzów 2; Sw-3, 4, 8, 10 – Swarzów 3, 4, 8, 10

GEOLOGICAL SETTING

In the basement rocks, below the Miocene and Upper Cretaceous strata of the Carpathian Foreland (Fig. 1), an Upper Jurassic–Lower Cretaceous carbonate complex occurs. These deposits encompass a continuous stratigraphic section from the Upper Dogger to Tithonian, locally to the Lower Cretaceous, inclusively. This area belonged to the carbonate platform of the northern margin of the Tethys Ocean (Peri-Tethys) during these times.

In 1976, Morycowa and Moryc working on the Upper Jurassic deposits in the Dąbrowa Tarnowska–Szczucin area, distinguished two lithostratigraphic formations within the upper part of the carbonate complex: the lower, coral-algal limestones formation and the upper, limestone-dolomitic, coquina formation. They assigned the Late Oxfordian ("Astartian") age to the lower, coral-algal limestones formation; the upper one they included entirely into the Kimmeridgian. This idea has been subject to certain changes, due to the weak recognition of biostratigraphic factors during the time of these studies. The changes derived from later investigations based on the elaboration of new microfossil assemblages. Such studies contributed to a more detailed recognition of the assemblages' age and, in effect, of their "rejuvenation". Morycowa and Moryc (2011) presented the actual view concerning the age of these deposits, taking into account the results of the newest biostratigraphic studies of many authors as well as their own investigations.

The papers by Matyja and Barski (2007), Barski and Matyja (2008), and Matyja (2009), which based the stratigraphy of the discussed deposits on the organic dinoflagellates, introduced their own proposals into the informal lithostratigraphic units of the Upper Jurassic deposits in this part of the Carpathian Foreland, including the region north of Dąbrowa Tarnowska. The age of the quoted lithostratigraphic units was also supported by additional studies by Morycowa and Moryc (2011) based on the occurrence of calpionellids.

The corals, abundant in the coral-algal limestone formation, are the subject of the present paper. They construct small but dense patches constituting, perhaps, fragments of the biostructures of biostrom type (Morycowa, 1985). The skeletons of other organisms, algae (green and red), sponges, bryozoans, brachiopods and echinoderms, among the others, accompany the coral fauna. The much diversified complex of carbonate deposits, described in detail in Morycowa and Moryc (1976), is included into the coral-algal formation.

The present author accepted the lithostratigraphic scheme of the described carbonate complex (Morycowa &

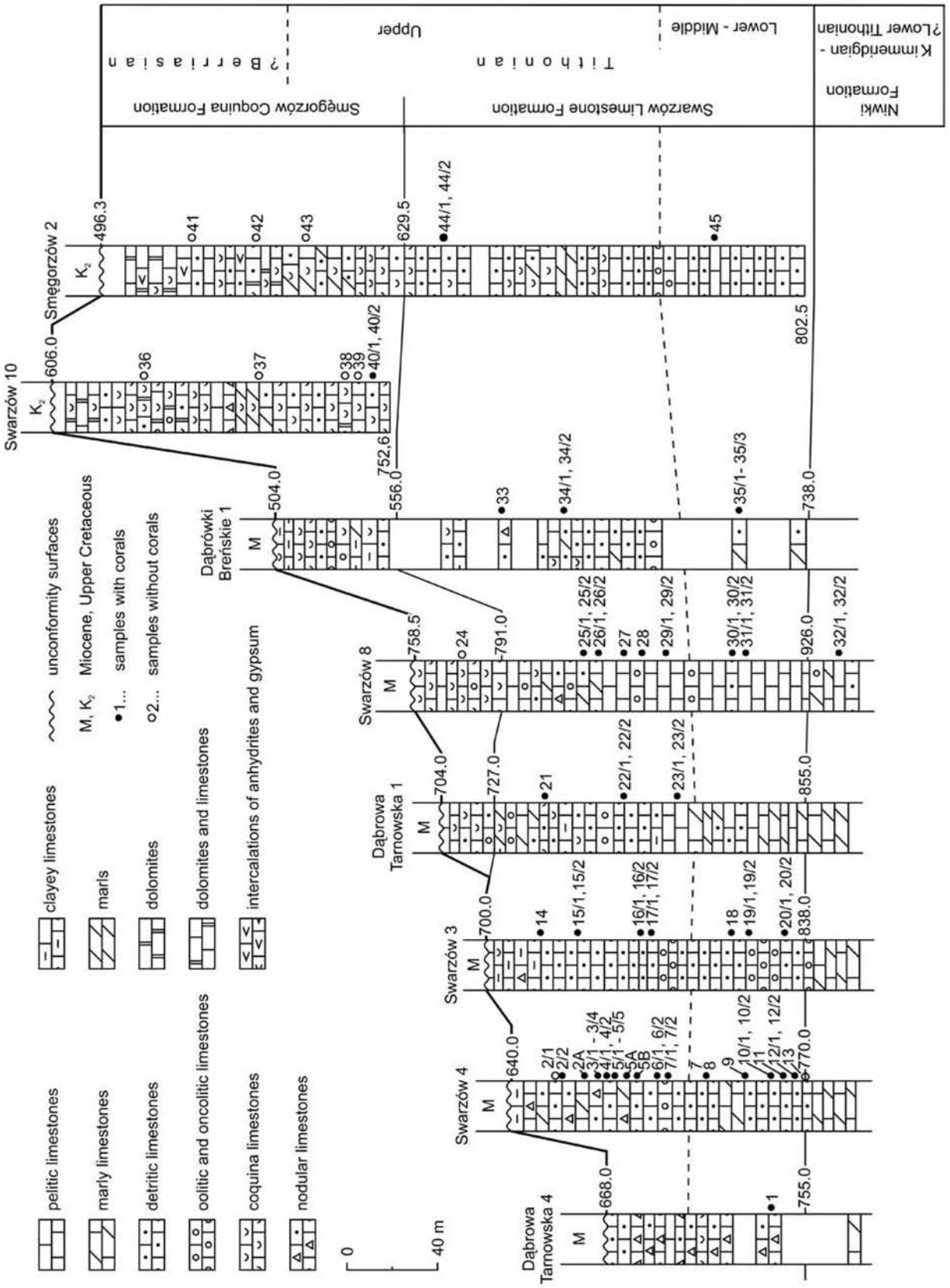

Fig. 2. Correlation and location of samples from the Swarzów Limestone Formation and Smęgorzów Coquina Formation, collected from boreholes in the Dąbrowa Tarnowska–Szczucin area; dashed line marks the probable lower boundary of the Upper Tithonian

Moryc, 2011), according to the division shown in Fig. 2. The dashed line marks the assumed boundary dividing the Swarzów Limestone Formation into the Upper Tithonian and the older parts.

Summarizing, above the carbonate-marly Niwki Formation (Fig. 2), the Tithonian coral-algal limestones (Swarzów Limestone Formation) is covered by the limestone-dolomitic coquina formation (Smęgorzów Coquina Formation), whose age is not quite precisely defined. It is likely that the latter formation still belongs to the Tithonian and, at least partly, to the earliest Berriasian in the Dąbrowa Tarnowska–Szczucin area.

REMARKS ON THE PALAEOENVIRONMENT OF CORALS

Scleractinian corals from the Upper Jurassic–?Berriasian coral-algal limestone formation (Swarzów Limestone Formation) of the Polish Carpathian Foreland in the Dąbrowa Tarnowska–Szczucin area belong to the shallow-water ecological group. Their development took place in a low- and periodically in high-energy environments, with periodic influence of the open sea (due to the presence of plankton typical of open sea) on the shallow, carbonate platform of the northern Tethyan margin. It is a limestone complex, attaining around 140–180 m in thickness, composed of creamy-beige limestones, including pelitic (micrite, pelmicrite), organogenic (biomicrite, biopelmicrite), organodetritic (biointramicrite, biointrasparite), oolitic, pizolitic, oncolitic limestones, occasionally dolomitized to a variable degree (dolomitic limestones), as well as marls and, in places, marly limestones.

The coral remnants constitute only one of the detrital components of the limestones formed in a high-energy milieu (*i.a.* organodetritic, oncolitic and oolitic).

Corals from the organogenic limestones (biomicrites) and marly limestones are often in the life position and the presence of, *i.a.*, micritised skeletons, association of well preserved microencrusters and boring biota provide evidence for their development in a calm sea environment typified by slow sedimentation rate.

Thin-lamellar and ramose (mainly phaceloid), much less frequently submassive and massive are the characteristic coral growth forms. Solitary coralla are scarce. The lamellar colonies, predominantly from the Microsolenidae, dominate in the lowest part of the shallow-water Swarzów Limestone Formation. They resemble the European Upper Jurassic and Lower Cretaceous platy microsolenid assemblages, which derived from low hydrodynamic environments (compare, *i.a.*, Roniewicz & Roniewicz, 1971; Morycowa, 1974; Geister & Lathuilière, 1991; Insalaco, 1996; Insalaco *et al.*, 1997; Dupraz & Strasser, 2002; Gutowski, 2004; Morycowa & Masse, 2009), but they are considerably poorer in specimens and species.

The colonies are small, their range varies from 3 cm up to 8 cm in size (cross section of the core), and the thickness of lamellar colonies usually does not exceed 3 cm, while that of massive and dendroid ones reaches *ca.* 10 cm.

The corals occur as dispersed coralla or as clusters, of thickness mainly up to 20 cm in the sections of the studied limestones. These small, dense clusters may have constituted fragments of larger biostructures such as biostromes or bioherms.

TAXONOMIC CHARACTER OF THE STUDIED CORAL FAUNA

The coral assemblage is composed of about 70 selected specimens, collected from the coral-bearing limestones (Swarzów Limestone Formation), from which about 140 thin sections were made to allow for taxonomic identification. Thus it is obvious that the taxonomic diversity of the coral fauna in this limestone is in reality much higher than presented herein (Table 1). The most representative is the set of corals from Swarzów 4 borehole.

The state of preservation of these coral skeletons differs depending on their palaeonvironmental setting and their diagenesis. Generally, they are poorly preserved and difficult to extract from the rocks. Thus, almost all specimens have been studied chiefly on the basis of thin sections, on which in places, traces of the original skeletal microstructure and micromorphology have been preserved and made their identification possible.

The examined assemblage comprises 42 species (among them 14 are left in open nomenclature and 2 are new ones) belonging to 26 genera, 11 families, 6 suborders and 2 orders: Scleractinia and Hexanthiniaria; all taxa, except one, belong to the order Scleractinia.

The most frequent and diversified (Table 1) are corals from the families Stylinidae (6 species), Montlivaltiidae (7 species) and Microsolenidae (7 species). Thin lamellar corals, predominantly from the family Microsolenidae, dominate in the lowest part of the Swarzów Limestone Formation. In the Jurassic of the Carpathian Foreland, it is the first stage of development of the coral fauna.

Almost complete lack of the taxa characteristic of and abundant in the shallow-water European Tithonian, such as representatives of the suborder Pachythecaliina Eliašova, 1976 (compare, *i.a.*, Ogilvie, 1897; Geyer, 1955a; Morycowa, 1964a, 1974; Eliášová, 1975, 1976a; Kołodziej, 2003), is the distinctive feature of the examined coral assemblage, which is assumed to be Tithonian in age.

Generally, the coral assemblage displays a Late Jurassic character. It contains species common in the Upper Oxfordian–Tithonian faunas from many areas in Europe and Western Asia. (*i.a.*, Becker & Milaschewitsch, 1875–1876; Koby, 1880–1889; Ogilvie, 1897; Mirchink, 1937; Geyer, 1954, 1955a, 1955b; Beauvais, 1964; Roniewicz, 1966, 1976; Babaev, 1973; Eliášová, 1973, 1976b, 1981, 1994; Turnšek 1972, 1997; Morycowa, 1964a, 1974; Bendukidze, 1949, 1982; Errenst, 1990, 1991; Lauxmann, 1991; Bertling, 1993; Kołodziej, 1997). The broader stratigraphic span is assigned to some species, which are quoted from the Middle Jurassic (*cf.* Pandey & Fürsich, 2003), and some species lasted until the Berriasian and/or Valanginian (*cf.* Morycowa, 1968; Eliašová, 1990; Roniewicz, 2008; Masse *et al.*, 2009).

Table 1

List of determined coral taxa from the Swarzów Limestone Formation and Smęgorzów Coquina Formation in the Dąbrowa Tarnowska–Szczucin region

Occurrences / Species	Dąbrowa Tarnowska 4	Swarzów 4	Swarzów 3	Dąbrowa Tarnowska 1	Swarzów 8	Dąbrówki Breńskie 1	Swarzów 10	Smęgorzów 2
Mitrodendron sp.								44/1
Stylosmilia corallina			19/1				40/1	
Stylosmilia octonaria		5A	15/1					
Stylina parviramosa						34/1		
Stylina tubulifera		10/1						
Pseudocoenia radisensis		3/1, 5/5, 7/1						
Pseudocoenia hexaphyllia				23/1				
Enallhelia tubulosa		6/1						
Heliocoenia humberti		10/2						
Rhipidogyra sp.						33		
Aplosmilia sp.				22/1				
Tiaradendron sp.					29/1			
Placogyra hykeli		7/2						
Ironella giseldonensis		3/2, 3/3						
Montlivaltia sp.		4/1						
Thecosmilia trichotoma				21				
Thecosmilia dichotoma		3/3						
Complexastrea burgundiae		2/2	18					
Complexastrea magna sp.n.					32/1			
Complexastrea dabroviensis sp. n.		5/2						
Clausastrea sp.		11						
Isastrea helianthoides							40/2	
Isastrea bernensis		5/1	19/2		27	34/2		
Myriophyllia rastellina		6/2, 12/1, 12/2						
Dermosmilia sp.		4/2						
Calamophylliopsis cervina			20/1					
Calamophylliopsis sp.			20/2					
Thamnasteria concinna		3/4, 5/3 5/4, 9	17/1					
Thamnasteria sp.					29/2			
Microsolena agariciformis		6/1						
Micosolena exigua			16/1		32/2	35/1		
Microsolena ornata	1		16/2		26/1			
Comoseris minima					26/2, 30/1, 31/1			
Comoseris cf. *interrupta*					31/2			
Comoseris sp.								45
Meandrarea gresslyi		5B	17/2					
Microsolenidae indet.					30/2			
Epistreptophyllum sp.						33		
Latomeandra ramosa				23/2				
?Latomeandra sp.				22/2				
Fungiastraea subtilis						35/2		44/2
Fungiastraea aff. *subtilis*						35/3		
Protoseris sp.			15/2, 16/1					
Indeterminable		2A, 8	14		25/1, 25/2			

SYSTEMATIC PALAEONTOLOGY

The highest systematic categories within the Mesozoic corals used here generally follow Alloiteau (1952, 1957) and Wells (1956), with some modifications and supplements by Eliášová (1976a), Roniewicz (1976), Morycowa and Roniewicz (1995a), and Roniewicz and Stolarski (2001).

The terminology of the coral structure follows that of Alloiteau (1952, 1957) and Wells (1956), with some additional terms concerning the microstructure and micromorphology of skeletons (*e.g.*, Gill, 1967, 1977) and corallum growth forms (phaceloid = pseudocolonial; Coates & Jackson, 1985).

Diameters of trabeculae (measured in transverse thin sections of radial elements) are used after Morycowa and Roniewicz (1995b): *minitrabeculae* (small trabeculae) – of diameters up to 50 μm, in some cases coalescing with each other and forming mid-septal line; *medium-size trabeculae* – of diameters from about 50 to 100 μm, and *thick trabeculae* – over 100 μm.

The synonymy listed in descriptions is simplified. For a more complete list the reader is directed to selected paper (with synonymy). Name spelling of genera in the synonyme list is as in the quoted publications.

Abbreviations and terminology used in descriptions:

D – corallum diameter (two perpendicular diameters; in mm),
H – height of corallum (maximum; in mm),
d cor – corallite diameter,
d cal – calice diameter,
dl – calice lumen,
cor-cor – distance between corallites,
c-c – distance between centres of corallites,
w series – width of corallite series (width between the walls or colline tops),
col-col – distance between collines of adjacent corallite series,
S – number of septa in the corallite,
S1, S2-Sn – septa (radial elements) of successive size orders (which may or may not correspond to cycles),
den s – density of septa per mm (measured in the wall zone or in the outer zone of corallites),
den trab – density of trabeculae measured along the septal plate, in transverse section (as skeletons are recrystallized, preserved trabecular outlines are considered),
d trab – diameter of trabeculae measured along the septal plate, in transverse section,
den dis – density of endothecal elements (longitudinal section) per mm,
den pen – density of pennulae per mm in longitudinal section,
(...) – less frequent values are presented in brackets,
((...)) – sporadic values.

List of the identified taxa:

Order HEXANTHINIARIA Montanaro-Gallitelli, 1975:
Suborder PACHYTHECALIINA Eliášová, 1976
Family AMPHIASTRAEIDAE Ogilvie, 1897
Genus *Mitrodendron* Geyer, 1955
Mitrodendron sp.
Order SCLERACTINIA Bourne, 1900
Suborder STYLININA Alloiteau, 1952
Family STYLINIDAE d'Orbigny, 1851
Genus *Stylosmilia* Milne Edwards et Haime, 1848
Stylosmilia corallina Koby, 1881
Stylosmilia octonaria Roniewicz, 1976
Genus *Stylina* Lamarck, 1816
Stylina parviramosa Beauvais, 1964
Stylina tubulifera (Phillips, 1829)
Genus *Pseudocoenia* d'Orbigny, 1850
Pseudocoenia radisensis (d'Orbigny, 1850)
Pseudocoenia hexaphyllia (d'Orbigny, 1850)
Family EUHELLIIDAE Vaughan et Wells, 1943
Genus *Heliocoenia* Etallon, 1859
Heliocoenia humberti Etallon, 1859
Genus *Enallhelia* Milne Edwards et Haime, 1849
Enalhelia tubulosa Becker, 1875
Suborder RHIPIDOGYRINA Roniewicz, 1976
Family RHIPIDOGYRIDAE Koby, 1905
Genus *Rhipidogyra* Milne Edwards et Haime, 1848
Rhipidogyra sp.
Genus *Aplosmilia* d'Orbigny, 1849
Aplosmilia sp.
Genus *Tiaradendron* Quenstedt, 1852
Tiaradendron sp.
Genus *Placogyra* Koby, 1904
Placogyra hykeli Eliášová, 1973
Genus *Ironella* Starostina et Krasnov, 1970
Ironella giseldonensis Starostina et Krasnov, 1970
Suborder FAVIINA Gregory, 1900
Family MONTLIVALTIIDAE Dietrich, 1926
Genus *Montlivaltia* Lamouroux ,1821
Montlivaltia sp.
Genus *Thecosmilia* Milne Edwards et Haime, 1848
Thecosmilia trichotoma (Goldfuss, 1826)
Thecosmilia dichotoma sensu Koby, 1884
Genus *Complexastrea* d'Orbigny, 1849
Complexastrea burgundiae (de Blainville, 1830)
Complexastrea magna sp.n.
Complexastrea dabroviensis sp.n.
Genus Clausastrea d'Orbigny, 1849
Clausastrea sp.
Family ISASTRAEIDAE Alloiteau, 1952
Genus *Isastrea* Milne Edwards et Haime, 1851
Isastrea helianthoides Goldfuss, 1826
Isastrea bernensis Etallon, 1864
Family FAVIIDAE Gregory, 1900
Genus *Myriophyllia* d'Orbigny, 1849
Myriophyllia rastellina (Michelin, 1843)
Family DERMOSMILIIDAE Koby, 1889
Genus *Dermosmilia* Koby, 1884
Dermosmilia sp.
Genus *Calamophylliopsis* Alloiteau, 1952
Calamophylliopsis cervina (Etallon, 1860)
Calamophylliopsis sp.
Suborder FUNGIINA Verrill, 1865
Family TAMNASTERIIDAE Vaughan et Wells, 1943
Genus *Thamnasteria* Lesauvage, 1823
Thamnasteria concinna (Goldfuss, 1826)
Thamnasteria sp.
Suborder MICROSOLENINA Morycowa et Roniewicz, 1995
Family MICROSOLENIDAE Koby, 1889
Genus *Microsolena* Lamouroux, 1821
Microsolena agariciformis Etallon, 1859
Microsolena exigua Koby, 1887
Microsolena ornata Koby, 1887
Genus *Comoseris* d'Orbigny, 1849
Comoseris minima Beauvais, 1964

Comoseris cf. *interrupta* Koby, 1888
Comoseris sp.
Genus *Meandrarea* Etallon, 1859
Meandrarea gresslyi Etallon, 1864
Microsolenidae indet.
Family LATOMEANDRIDAE Alloiteau, 1952
Genus *Epistreptophyllum* Milaschewitsch, 1876
Epistreptophyllum sp.
Genus *Latomeandra* Milne Edwards et Haime, 1848
Latomeandra ramosa (Koby, 1884)
Latomeandra sp.
Genus *Fungiastraea* Alloiteau, 1952
Fungiastraea subtilis Eliášová et Roniewicz, 1990
Fungiastraea aff. *subtilis* Eliášová et Roniewicz, 1990
Genus *Protoseris* Mine Edwards et Haime, 1851
Protoseris sp.

Order HEXANTHINIARIA Montanaro-Gallitelli, 1975
Suborder PACHYTHECALIINA Eliášová, 1976, emend. Roniewicz et Stolarski, 2001
Family AMPHIASTRAEIDAE Ogilvie, 1897, emend. Roniewicz et Stolarski, 2001
Genus *Mitrodendron* Quenstedt, 1881
Type species: *Lithodendron mitratum* Quenstedt, 1858

Mitrodendron sp.
Fig. 3A

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	d cor	d l	S
Smęgo-rzów 2	639.0–645.8 IV*	(44/1a)	4.5×7.0 6.5× *ca.* 8.0	2.8–3.5	*ca.* 40 (12S1+S2+ nS3–S4)

* Number of the core-box

Remarks: Only three not well-reserved corallites from the genus *Mitrodendron* were found in the cross section of the core limestone. The corallite diameters and hexameral – slightly bilateral septal symmetry put them close to *Mitrodendron modicum* Eliášová from the Upper Tithonian of Štramberk (Eliášová, 1975). However, owing to the scanty and poor preservation material, a more precise comparison is impossible.

Order SCLERACTINIA Bourne, 1900
Suborder STYLININA Alloiteau, 1952
Family STYLINIDAE d'Orbigny, 1851
Genus *Stylosmilia* Milne Edwards et Haime, 1848
Type species: *Stylosmilia michelini* Milne Edwards et Haime, 1848

Stylosmilia corallina Koby, 1881
Fig. 3B

1881. *Stylosmilia corallina* Koby, p. 62, pl. 14, figs 3–7.
1990. *Stylosmilia corallina* Koby: Errenst, p. 176, pl. 5, fig. 4a, b (with synonymy).
1990. *Stylosmilia corallina* Koby: Eliášová, p. 118, pl. 1, fig. 1.
1991. Stylosmilia corallina Koby: Lebanidze, p. 13, pl. 3, fig. 1a, b.
1997. *Stylosmilia corallina* Koby, Kołodziej, pp. 40–41, pl. 5, fig. 5a–c
1997. *Stylosmilia corallina* Koby: Turnšek, p. 196, pl. 196, figs a–f.
2004. *Stylosmilia corallina* Koby: Mišik & Morycowa, p. 314, fig. 3.11.
2008. *Stylosmilia corallina* Koby: Roniewicz, p. 100, fig. 5f, k.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	d cor	d l	S
Smęgo-rzów 3	811.3–817.3, II	19/1 (19/1a)	1.5–2.0	1.0×1.5	12 (6S1+6S2)
Smęgo-rzów 10	742.1–746.3, IV	40/1 (40/1a)	2	1.4	24 (6+6+nS3)

Remarks: Limestones with several corallum branches. Corallites rounded in cross section. Costo-septa of two complete cycles and occasionally rudimentary third cycle. Septa S1 almost reach the columella, septa S2 constitute *ca.* 1/2 length of S1. Auriculae of S1 and S2 septa distinctly developed. Costae and septotheca strongly recrystallized. Endotheca tabuloid. Budding lateral.
Distribution: The species is known from the Middle Oxfordian to Kimmeridgian in: Spain, France, Switzerland, Germany, Poland, Romania, Slovenia, Czech Republic, Georgia, Croatia, Azerbaijan and Ukraine; from the Tithonian in: Czechia (Štramberk) and Serbia.

Stylosmilia corallina has also been described from the Upper Jurassic in China (Tibet), from the Upper Jurassic–Lower Cretaceous (Berriasian) of the Polish and Czech Outer Carpathians, Valanginian of Bulgaria, and as *S.* cf. *corallina* from the Upper Valanginian of southern France (Masse *et al.*, 2009).

Stylosmilia octonaria Roniewicz, 1976
Fig. 3C, D

1976. *Stylosmilia octonaria* sp.n.: Roniewicz, pp. 56–57, pl. 8, fig. 5a, b.
non 1991. *Goniocora octonaria* Roniewicz: Lauxmann, pp. 127–128, pl. 2, fig. 6.
part. 2008. *Stylosmilia octonaria* Roniewicz: Roniewicz, p. 100, fig. 5e (not fig. 5h).

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	d cor	d l	S
Swarzów 4	689.2–695.3, III	5A (5A)	1.5	1.3	16 8S1+8S2
Swarzów 3	738.3–743.9, IV	15/1 (15/1a)	*ca.* 2	1.4	16+nS3 (8+8+n S3)

Remarks: Only several sections of the branches of phaceloid coralla have been preserved. On account of the diameter of corallites, and number and symmetry of costo-septa, the specimens correspond to *Stylosmilia octonaria* Roniewicz.
Distribution: Lower Kimmeridgian of Romania; Tithonian and Valanginian of Bulgaria.

Genus *Stylina* Lamarck, 1816
Type species: *Stylina echinulata* Lamarck, 1816

Stylina parviramosa Beauvais, 1964
Fig. 3G–I

1881. *Stylina bernardana* d'Orbigny: Koby, p. 80, pl. 17, figs 4, 5.
1964. *Stylina parviramosa* nov. sp. Beauvais, p. 137, pl. 9 fig. 5; pl. 10, fig. 2.
1966. *Stylina parviramosa* Beauvais: Roniewicz, pp. 198–199, p. 8, fig. 6a, b.

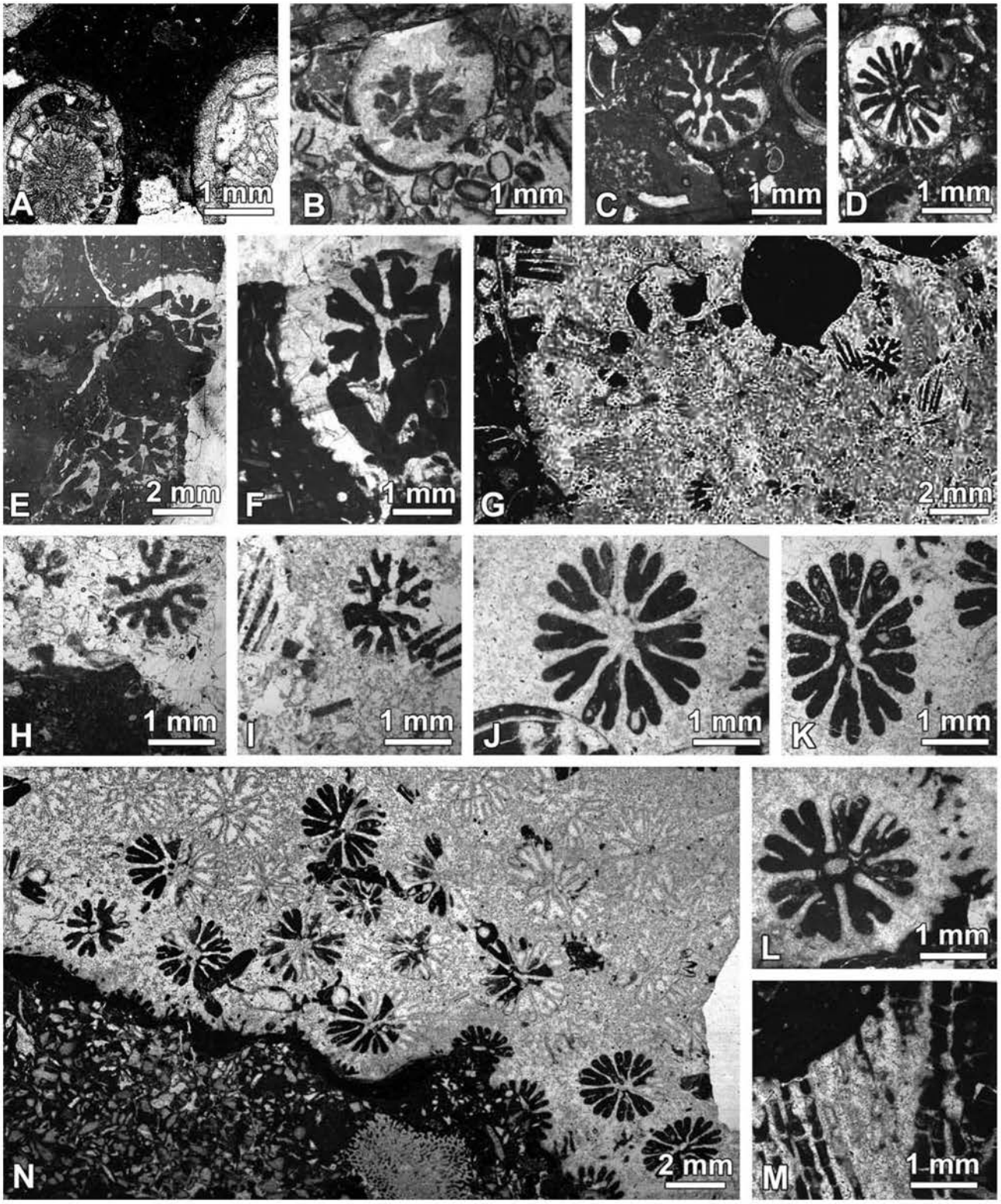

Fig. 3. **A** – *Mitrodendron* sp.: A – transverse section of corallites (thin section No. 44/1a). **B** – *Stylosmilia corallina* Koby: transverse thin section (No. 40/1a) showing corallite with costo-septa of three size orders and auriculae in internal septal margins. **C, D** – *Stylosmilia octonaria* Roniewicz: C – corallite in transverse thin section (No. 5A); D – the same species (thin section No. 15/1a). **E, F** – *Enallhelia tubulosa* Becker: E – thin section (No. 6/2a) presenting branch fragment with two corallites; F – enlarged corallite from the same thin section showing septal octomeral symmetry. **G–I** – *Stylina parviramosa* Beauvais: G – transverse thin section (No. 34/1a) of small massive colony; H–I – enlarged details of the colony presented in Fig. G, showing corallites with septa of two size orders arranged in octomeral symmetry. **J–N** – *Stylina tubulifera* (Phillips): J–L – enlarged corallites of thin section No. 10/1a, presented in Fig. N, with typically decameral septal symmetry (Fig. J) and sporadically irregular decameral (Fig. K) and octomeral symmetry (Fig L); M – longitudinal thin section (No. 10/1b; N – transverse thin section (No. 10/1a) of colony fragment

1985. *Stylina parviramosa* Beauvais: Rosendahl, p. 40, pl. 3, fig. 8.
1990. *Stylina parviramosa* Beauvais: Errenst, p. 179, pl. 6, fig. 2a-d.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d l	c-c	S	C
Dąbrówki Breńskie 1	627.6–833.2, III	34/1 (34/1a, b)	40×45; *ca.* 35	*ca.* 1.5	2.0–2.5	8S1+8S2 +nS3	16+nS3

Remarks: Corallum submassive with upper surface irregularly and heavily convex. This specimen possesses all features of the species *Stylina parviramosa*, described by Beauvais (Beauvais, 1964).

Distribution: The species is common in the European Upper Oxfordian–Kimmeridgian of Poland, France, Spain and Portugal.

Stylina tubulifera (Phillips, 1829)
Fig. 3J–N

1851. *Stylina tubulifera* (Phillips): Milne Edwards & Haime, p. 76, pl. 14, fig. 3.
1980. *Stylina tubulifera* (Phillips): Liulieva & Permiakov, p. 131, pl. 57, fig. 3.
1990. Stylina *tubulifera* (Phillips): Errenst, pp. 179–180, p. 6, fig. 3a, b (with synonymy).
1997. *Stylina tubulifera* (Philips): Kołodziej, pp. 41-42, pl. 6, fig. 3.
2005. *Stylina tubulifera* (Philips): Helm, pp. 101-102, pl. 32, fig. 5.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d l	c-c	S	C
Swa-rzów 4	749.3–756.5, V	10/1 (10/1a–g)	50×40; *ca.* 30	2–3	2.8–4.5 (6)	20 (10 S1+10 S2 (rarely 8+8 and 9+9 S1+S2)	(16–18) 20+n C3

Description: Massive, plocoid colony. Costo-septa generally regularly arranged in decameral symmetry, but the corallites with 8 and 9 septa S1 also occur (Fig. 3K, L). Those of S1 size order are long, often reach the columella, while S2 attain half of the length of S1. Radial elements of the third order marked in some corallites, as costae on the wall surface. Columella slightly elongated. Wall septo-parathecal. Dissepiments thin-walled. Budding intercalicular.

Remarks: The specimen described here is characterized by irregular decameral septal symmetry. It is likely that this character may be due to intraspecific variability. Similar variability in septal symmetry was observed in the thin section (No. 691) of one of the specimens of *Stylina tubulifera* from the Michelin collection (Museum d'Histoire Naturelle, Paris).

Distribution: Middle Oxfordian–Kimmeridgian: Spain, Portugal, England, France, Switzerland, Germany, Poland, Ukraine and Azerbaijan. Tithonian of Czech and Polish Outer Carpathians. Morycowa (1964b) described from the Barremian–Lower Aptian deposits of the Polish Outer Carpathians a colony not differing macro- and microscopically from those known from the Upper Jurassic.

Genus *Pseudocoenia* d'Orbigny, 1850
Type specimen: *P. suboctonis* d'Orbigny, 1850

Pseudocoenia radisensis (d'Orbigny, 1850)
Fig. 4A–D

1850. *Cryptocoenia radisensis*: d'Orbigny, t. II, p. 33.
1990. *Pseudocoenia radiensis* (d'Orbigny): Errenst, p. 169, pl 3, fig. 3a, b (with synonymy).
1991. *Cryptocoenia radisensis* d'Orbigny: Lebanidze, p. 11, pl. 2, fig. 1a, b.
1997. *Pseudocoenia radisensis*(d'Orbigny): Turnšek, p. 170, fig. 170.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d l	c-c	S	C	den end
Swa-rzów 4	677.8–682.2, I	3/1 (3/1a, b)	35×50; 40	2.0–2.8	3.0–5.5 (6)	12+nS3	12–24	5/2
	677.8–682.2, III	5/5 (5/5a)	45×50; 30	2.0–2.5	3.2–5.5	12+nS3	12+nS3	
	702.1–709.0, IV	7/1 (7/1a)	15×20; 6	2.0–2.5	2.5–4 (6)	12: 6S1+6S2	12+nS3	

Description: Massive, plocoid colony and colony fragments with corallite lumens circular in cross sections. Costo-septa arranged in hexameral symmetry. Septa differentiated in two or three size orders. Septa S1 most frequently reach only 1/4 diameter of corallite and S2 constitute 1/2–1/3 length of S1. Costae lying on the prolongation of septa S1 and S2 are subequal. Costae corresponding to septa S3, observed in thin sections, are always considerably shorter than those corresponding to S1 and S2. Endotheca subtabuloid, exotheca vesicular, abundant. Budding intercalicinal.

Remarks: The specimens of *Pseudocoenia radisensis* from the Carpathian Foreland do not differ from the holotype of this species (coll. d'Orbigny, No. 4469, Museum d'Histoire Naturelle, Paris). In the holotype: d ca l = 2.5–3.0 mm, den end = 6/2 (*cf.* also Roniewicz, 1966).

Pseudocoenia radisensis resembles *Adelocoenia bernensis* (Koby) not Etallon (*cf.* Beauvais, 1964, p. 118), but the latter differs from the former in slightly smaller calices (in *A. bernensis*: d cal=2 mm, c-c=3–4 mm) and the presence of only two cycles of costo-septa (S=12: 1+S2).

Distribution: The species is known from the Oxfordian–Kimmeridgian of Portugal, Spain, France, Poland, Romania, Slovenia and Georgia.

Pseudocoenia hexaphyllia (d'Orbigny, 1850)
Fig. 4E

1850. *Cryptocoenia hexaphyllia* d'Orbigny: p. 33.
1889. *Convexastrea hexaphyllia* d'Orbigny: Koby, p. 471–472, pl. 125, fig. 1.
1964. *Cryptocoenia hexaphylli* d'Orbigny: Beavais, p. 126, pl. 6, fig. 7.
1991. *Cryptocoenia hexaphyllia* d'Orbigny: Lebanidze, p. 10, pl. 2, fig. 1a, b.
1997. *Pseudocoenia hexaphyllia* (d'Orbigny): Turnšek, p. 168, pl. 168 (with complementary synonymy).
2003. *Pseudocoenia hexaphyllia* (d'Orbigny): Pandey & Fürsich, p. 26–27, pl. 3, figs 2, 4.

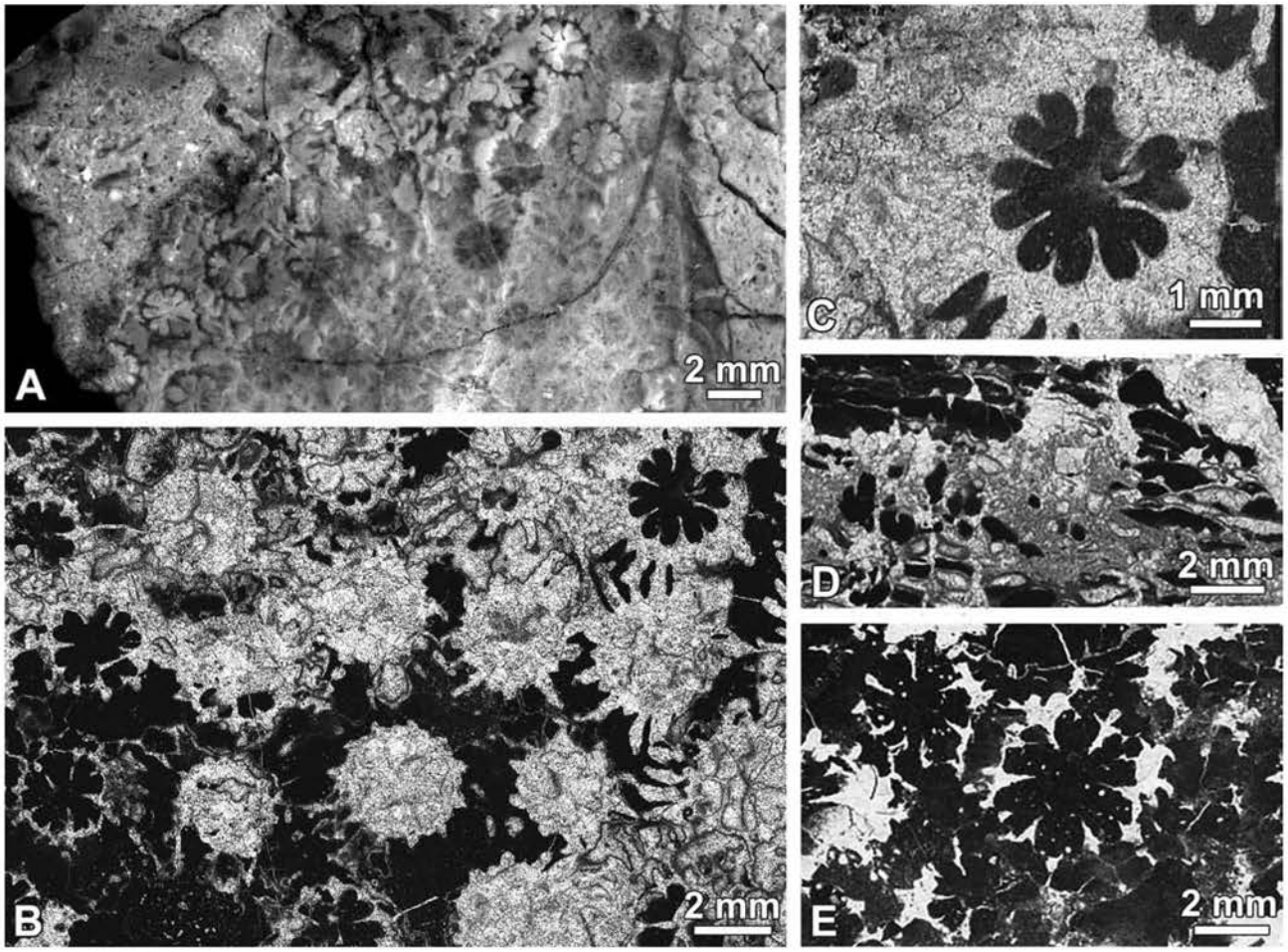

Fig. 4. **A–D** – *Pseudocoenia radisensis* (d'Orbigny): A – polished transverse section of colony (No. 3/1); B – the same colony in transverse thin section (No. 3/1a); C – enlarged corallite from thin section presented in Fig. B, showing costo-septa arranged in hexameral symmetry; D – longitudinal section showing thin, extended disspiments. **E** – *Pseudocoenia hexaphyllia* (d'Orbigny, 1850); trasverse thin section No. 23/1a

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d l	c-c	S	C	den end
Dąbrowa Tarnowska 1	783.3–786.7, I	23/1 (23/1a, b)	35×50; 24	3.5–4.0	4.5–6.0	6+6+nS3	12+nC3	5/2

Remarks: Fragment of plocoid colony corresponds to *Pseudocoenia hexaphyllia* (d'Orbigny). It differs from *Pseudocoenia radisensis* (d'Orbigny) in slightly larger diameters of corallites.

Pseudocoenia hexaphyllia described from the Lower Callovian from the east-central Iran (Pandey & Fürsich, 2003) differs from Late Jurassic specimens of this species in irregular hexameral septal symmetry.

Distribution: Early Callovian of Iran. Late Oxfordian–Kimmeridgian of Portugal, Spain, France, Switzerland, Germany, Poland, Romania, Serbia, Slovenia, Georgia. Late Jurassic of China (Liao Weihua & Xia Jinbao, 1985, 1994).

Family EUHELLIIDAE Vaughan et Wells, 1943
Genus *Enallhelia* Milne Edwards et Haime, 1849
Type species: *Lithodendron compressum* Godfuss, 1829

Enallhelia tubulosa Becker, 1875
Fig. 3E, F

1875–1876. *Enallohelia tubulosa* Becker: Becker & Milaschewitsch: p. 132, pl. 36, fig. 1a–c.
1904–1905. *Enallohelia tubulosa* Becker: Koby: p. 2, pl. 1, figs 2, 2a.
1991. *Enallhelia tubulosa* Becker: Lauxmann, pp. 131–132, pl. 3, fig. 2 (with synonymy).

Material and measurements (in mm):
(Sample No. 6/1 contains *Enallhellia tubulosa* and *Microsolena agariciformis*):

Well name	Depth in metres	Specimen and thin section numbers	dl	S	C
Swarzów 4	702.1–709.1, III	6/1 (6/1a)	1.6–2.0	16: 8S1+8S2	16+nC3

Remarks: Fragment of the branch with several corallites. Calices circular, 1.6–2.0 mm in diameter, with 16 septa, 8 S1 and very short, if present, S2. Short costae in continuation of septa S1–S2 and additionally some of third size order.

The Carpathian Foreland specimen corresponds in corallum growth form, corallite diameter and number of septa to *Enallhelia*

tubulosa Becker (compare Becker & Milaschewitsch, 1875–1876).
Distribution: Kimmeridgian of Portugal, Germany. Tithonian of Czech Outer Carpathians.

Genus *Heliocoenia* Etallon, 1859
Type species: *Heliocoenia variabilis* Etallon, 1859

Heliocoenia humberti Etallon, 1859
Fig. 5A–D

1859. *Heliocoenia Humberti* Etallon: pp. 475–476,
1881. *Heliocoenia Humberti* Etallon: Koby, p. 67, pl. 27, figs 3, 4.
non 1897. *Heliocoenia Humberti* Etallon: Ogilvie, p. 167, pl. 18, figs 3, 3a.
1968. *Heliocoenia* sp.: Morycowa, pp. 24–25, text-fig. 4, pl. 7, fig. 2a, b.
1981. *Heliocoenia (Kobycoenia) claudiopolisensis* Beauvais var. *minima* nov. var.: Beauvais et Bernier, p. 181, pl. 1, fig. 5; pl. 2, fig. 5.
1981. *Heliocoenia humberti* Etallon: Eliášová, pp. 128–129, pl. 8, fig. 1 (with synonymy).

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d l	c-c	S
Swarzów 4	749.3–756.5, V	10/2 (10/2a)	15×30; 15	0.8–1.2 (1.4)	1.5–2.8	20 (6S1+6S2+8 (12) S3

Description: Lamellar, plocoid colony. Corallite lumen suboval in transverse section. Costo-septa arranged in radio-bilateral, rarely radial, symmetry. Twelve septa S1 and S2 subequal in length, septa S3 generally weakly developed, absent in two sectors perpendicular to elongated columella (Fig. 5C). Oval columella lying on the prolongation of two septa S1.
Remark: According to Geyer (1955a, p. 184), *Heliocoenia humberti* Etallon described by Ogilvie (1897) represents a new species *Stylina strambergensis*, subsequently described by Eliášová (1981) as *Heliocoenia strambergensis* Geyer, 1955.

The author includes *Heliocoenia (Kobycoenia) claudiopolisensis* var. *minima* from the Upper Kimmeridgian of Jura (Beauvais & Bernier, 1981) in the synonymy of *H. humberti* on account of similar corallite parameters and similar arrangement of septa.
Distribution: Species known from the Upper Jurassic–Lower Cretaceous of Europe: Upper Oxfordian–Kimmeridgian of Switzerland and France. Tithonian and Upper Jurassic/Lower Cretaceous of Czechia (*cf.* Eliášová, 1990). Berriasian of the Polish Outer Carpathians (Morycowa, 1968).

Suborder RHIPIDOGYRINA Roniewicz, 1976
Family RHIPIDOGYRIDAE Koby, 1905
Genus *Rhipidogyra* Milne Edwards et Haime, 1848
Type species: *Lobophyllia flabellum* Michelin, 1843

Rhipidogyra sp.
Fig. 6A, B, H

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	Width of corallite	Length of corallite	den s	C
Dąbrówki Breńskie 1	602.0–609.3, I	33 (33a, b)	12–16	*ca.* 30	6-9 S1–S3/5+n S4	3S1+S2/5)

Discription: Fragment of a solitary, flabelliform corallum, distally elongated and geniculate. External corallum zone with thick costae corresponding to septa S1 and S2 (Fig. 6A). Radial elements differentiated into four to five size orders. Septa S1 distinguished by considerable thickness. Lonsdaloid and apophysal septa of the highest size orders present. Wall thick, columella lamellar.
Remarks: In the width of corallum, thick wall and density of radial elements this specimen is most similar to specimens of *Rhipidogyra flabellum* (Michelin) from the Oxfordian of France and Switzerland (Koby, 1880; Beauvais, 1964) as well as from the Tithonian of the Czech Outer Carpathians (Eliášová, 1973).

Aplosmilia d'Orbigny, 1849
Type species: *Lobophyllia semisulcata* Michelin, 1843

Aplosmilia sp.
Fig. 6F, G

Material and measurements (in mm):

Well name	Depth in metres	Thin section number	d	c-c between cor	S	den S	den c
Dąbrowa Tarnowska 1	783.3–786.7, I	(22/1a)	2–3	6.5–7.5	20 S1+S2+nS3	4–6/1 (2S1+1S2+nS3/1)	3–4/1

Description: Phaceloid corallum examined only in transverse section. Corallites small, circular and oval. Septa differentiated into three size orders, but those of the first size order considerably thicker than those of the higher orders. Internal borders of septa S1 and S2 with characteristic T-form. Lonsdaloid septa present. Costae correspond only to the septa of the first and second size orders. Columella thin, lamellar.
Remarks: The genus *Aplosmilia* is common in the Upper Jurassic, recorded from the European localities (*cf.* Koby, 1880; Beauvais, 1964). The species from the Carpathian Foreland have exceptionally small corallite diameter; it is not comparable with any known European species. Outside Europe, the Jurassic species of comparable calicular diameters, with septa disposed in hexameral symmetry, is *A. somaensis* Eguchi (*cf.* Löser & Mori, 2002).

Genus *Tiaradendron* Quenstedt, 1858
Type species: *Lobophyllia germinans* Quenstedt, 1852

Tiaradendron sp.
Fig. 7I, J

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	d cor	d l	S
Swarzów 8	861.9–867.4, II	29/1 (29/1a, b)	6-9	3.5-4.0	24+nS4 (S1+S2+S3+nS4

Description: Fragments of dendroid corallum. Corallite lumens circular in section, surrounded by thick wall. Septa S1 to S3 size orders arranged in regular hexameral symmetry (Fig. 7I). Occasionally small, apophysal-like septa occur. Traces of macrostructure and micromorphology of septa show its neoripidocanth type. Budding extracalicinal.
Remarks: *Tiaradendron* sp. from the Carpathian Foreland in corallite diameters resembles *Tiaradendron germinans* (Quenstedt) described by Roniewicz (2008) from the Valanginian of Bulgaria. However, both specimens from the Valanginian of Bulgaria and

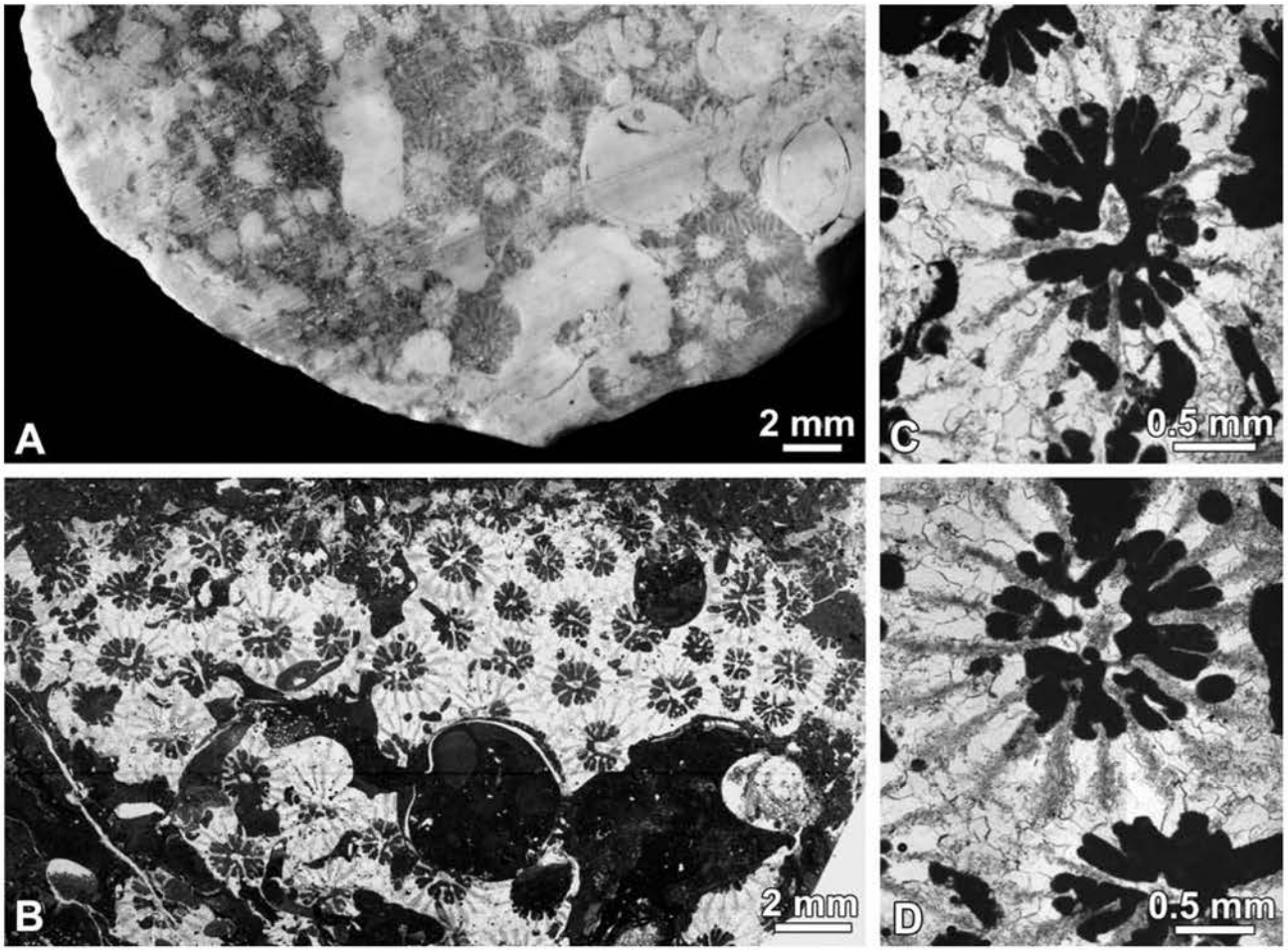

Fig. 5. **A–D** – *Heliocoenia humberti* Etallon: A – colony fragment in transverse section; polished surface (No. 10/2); B – transverse section of the same colony (thin section No. 10/2a); C, D – enlarged corallites from the same thin section, showing radio-bilateral symmetry in the arrangement of septa (two opposite sectors without CS3) and elongated columella

from the Tithonian of the Carpathian Foreland differ from the typical specimens of *T. germinans* in hexameral septal symmetry (not octomeral; *cf.* Becker & Milaschewitsch, 1875–1876). This specimen differs mainly in considerably smaller corallites from *Tiaradendron giganteum* Kapizke & Lauxmann from the Kimmeridgian of Germany (Lauxmann, 1991).

Genus *Placogyra* Koby, 1904
Type species: *P. felixi* Koby, 1904

Placogyra hykeli Eliášová, 1973
Fig. 6C–E

1973. *Placogyra hykeli*: Eliášová, p. 278, fig. 5, pl. 6, fig. 1a, b.
2008. *Placogyra hykeli* Eliášová: Roniewicz, p. 107, fig. 7d-f.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	Width of series	S	C
Swarzów 4	702.1-709.1, IV	7/2 (7/2a	*ca.* 6	3S1+2S2+ n S3–S4/5	3S1+S2/5

Description: Fragment of meandroid colony. Corallites indistinct in series. Radial elements differentiated into three or four size orders; those of the first order are considerably thicker than others and have T-shape at their internal borders (Fig. 6D). Septa S2 thinner and shorter than S1 and those of S3-S4 often lonsdaleoid. Lateral septal faces covered with fine, regular granules. Costae thick and subequal, occurring only on the prolongation of septa S1 and S2 (Fig. 6E). Columella thin, elongated. Wall parathecal. Numerous thin dissepiments visible in peripheral zone.
Remarks: The specimen described here agrees in series width, the macro- and micromorphology, and the density of radial elements with *Placogyra hykeli* Eliásová (Eliášová, 1973).
Distribution: Tithonian of the Czech Outer Carpathians. Tithonian/Berriasian boundary interval, and Valanginian of Bulgaria.

Genus *Ironella* Starostina et Krasnov, 1970
Type species: *Ironella giseldonensis* Starostina et Krasnov, 1970

Ironella giseldonensis Starostina et Krasnov, 1970
Fig. 7A–H

1970. *Ironella giseldonensis* Starostina et Krasnov: Krasnov & Starostina, p. 80, pl. 5, fig. 2.
1974. *Ironella giseldonensis* Starostina et Krasnov: Turnšek & Buser, pp. 95–96, 114, pl. 1, fig. 1.
1997. *Ironella giseldonensis* Starostina et Krasnov: Turnšek, p. 106, pl. 106.

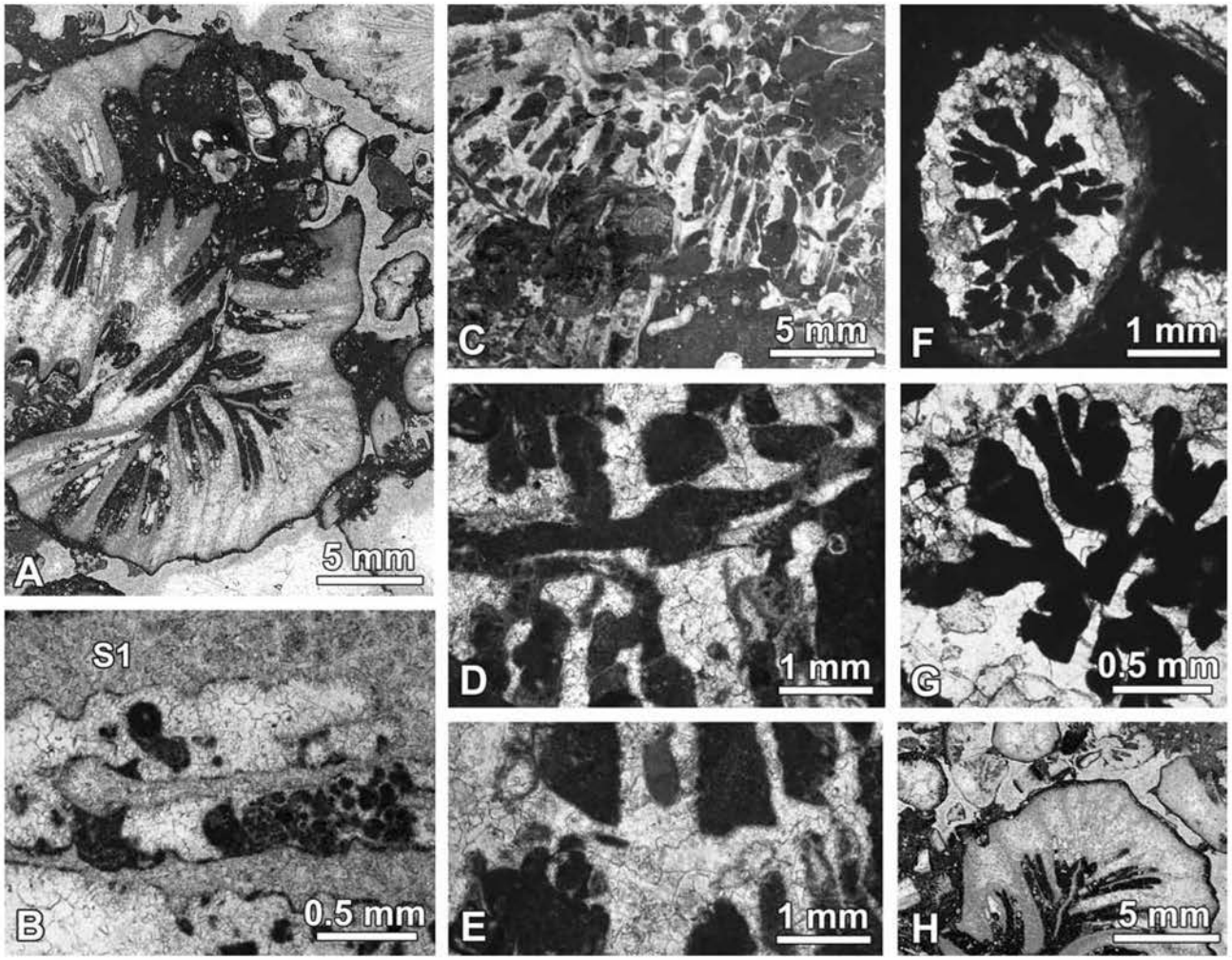

Fig. 6. **A, B, H** – *Rhipidogyra* sp.: A – distal part of corallum in transverse thin section (No. 33a), showing elongated and geniculated corallum with septa S1 (Fig. B) considerably thicker than others and thin lamellar columella. Prominent costae visible (centre, left); B – enlarged fragment of Fig. A, showing septa of four size orders with traces of neoripidocanth microstructure; H – fragment of the corallum presented in Fig. A in another thin section (No. 33b). **C–E** – *Placogyra hykeli* Eliášová: C – transverse thin section (No. 7/1a) of the fragment of corallite series; D – the same thin section presenting enlarged axial zone of series showing thin columella and very thick septa S1 with internal edges of T-form, septa S2 and S3 gradually thinner; E – the same thin section presenting wall zone with lonsdaloid septum and costae (top) corresponding to septa S1 and S2. **F, G** – *Aplosmilia* sp.: F – corallite in transverse thin section (No. 22/1a); G – enlarged corallite showing septa of three size orders, including considerably thicker septa S1 with apophysal septa

Material and measurements (in mm):
(Specimen Nos 3/2: *Ironella giseldonensis* occurs together with *Thecosmilia dichotoma*).

Well name	Depth in metres	Specimen and thin section numbers	D; H	d l	c-c	S	C
Swarzów 4	677.8–682.2, I	3/2 (3/2a–e)	40×45; 30	2.5–3.0	3.5–6.5	6S1+6S2+nS3	12–24
		(3/3c)	30×50	2.5–3.5	4.0–5.5	6S1+6S2+nS3	12–24

Description: Plocoid colony. Costo-septa arranged in hexameral symmetry and differentiated in three cycles. Septa S1 reach or almost reach corallite centres. They are thick and their internal borders are rhopaloid. Septa S2 constitute 1/2–1/3 length of S1. Costae lying on the prolongation of septa of the two first size orders are thick, subequal. Septa S3 are very short, occurring only in the wall zone and costae corresponding to them are always considerably shorter and thinner than those corresponding to septa S1 and S2. Lonsdaloid-like septa rarely present. Lateral septal faces regularly granulated. Endotheca subtabuloid, exotheca composed of thick subtabuloid elements, between which abundant vesicular ones occur. Budding intercalicinal.

Microstructure: The skeletal microstructure is not well preserved, but its vestiges, visible in places, indicate the rhipidogyrin type (Fig. 7C, F).

Remarks: The specimen included here in species *Ironella giseldonensis* seems to be identical with that described by Krasnov and Starostina (1970). Very close to this species is *I. rutimeyeri* (Koby) from the Lower Kimmeridgian of Romania (compare Roniewicz, 1976), but it has additionally septa S4 and all costae subequal.

Distribution: Tithonian of Osetia; Valanginian of Slovenia.

Suborder FAVIINA Gregory, 1900
Family MONTLIVALTIIDAE Dietrich, 1926
Genus *Montlivaltia* Lamouroux ,1821
Type species: *Montlivaltia cayophylloides* Lamouroux, 1821

Montlivaltia sp.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D	S
Swarzów 4	677.8–682.2, II	4/1 (4/1a)	16x10	*ca.* 70

Description: Solitary coral represented by one corallum fragment. Corallite oval in transverse thin section with about 70 radial elements differentiated into 4 size orders and accessory S5. About 10 of them reach the centre of the corallites. Septa S1 and S2 subequal in thickness, others gradually thinner and shorter. Lateral surface of septa with regular granulations. The state of preservation does not allow for specific identification.

Genus *Thecosmilia* Milne Edwards et Haime, 1848
Type species: *Lithodendron trichotomum* Goldfuss, 1826

Thecosmilia trichotoma (Goldfuss, 1826)
Fig. 8A

1826. *Lithodendron trichotomum* sp.n.: Goldfuss, p. 45, pl. 13, fig. 6.
1884. *Thecosmilia trichotoma* Münster: Koby, pp. 168–169, pl. 45, figs 1, 1a, 2.
?1960. *Thecosmilia trichotoma* (Goldfuss): Roniewicz, pp. 454–456, pl. 1, figs 1, 2; pl. 2, figs 1–4; pl. 3, figs 1, 2.
1976b. *Thecosmilia trichotoma* (Goldfuss): Eliášová, p. 169, pl. 4, fig. 2.
1977. *Thecosmilia trichotoma* (Goldfuss): Papojan, pp. 36–37, pl. 2, fig. 2.
1980. *Thecosmilia trichotoma* (Goldfuss): Liulieva & Permiakov, p. 109, pl. 31, fig. 3; pl. 32, fig. 1.
1982. *Thecosmilia trichotoma* (Goldfuss): Bendukidze, pp. 43–44, pl. 15, fig. 5.
1991. *Thecosmilia trichotoma* (Goldfuss): Lebanidze, pp. 22–23, pl. 7, fig. 3a, b.
1993. *Thecosmilia trichotoma* (Goldfuss): Bertling, pp. 90–91, pl. 2, figs 3, 4.
1994. *Thecosmilia trichotoma* (Goldfuss): Eliášová, p. 67, pl. 2, figs 1–4.
1997. *Thecosmilia trichotoma* (Goldfuss): Turnšek, p. 206, pl. 206, figs a–c.
2005. *Thecosmilia trichotoma* (Goldfuss): Morycowa & Mišik, pp. 422–424, figs 5.1–8.
2006. *Thecosmilia trichotoma* (Goldfuss): Pandy & Fürsich, p. 48, text-fig. 3; pl. 1, figs 3, 4a, b (with additional synonymy).

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	H	d cor	cor-cor	S	den c	den tr
Dąbrowa Tarnowska 1	749.0–755.6, I	21 (21a–d)	70	(12) 16–18	3.0–15	60–80 (S1-S4+ n S5)	7/5 (3–4/2)	6–7/2

Remarks: Phaceloid corallum attributed to the species *Thecosmilia trichotoma* (Goldfuss). It is closest in corallite diameters and number of radial elements to *T. trichotoma* from the Tithonian of Štramberk (*cf.* Eliášová, 1976b).

Distribution: *T. trichotoma* is common in the Middle Oxfordian–Kimeridgian of Switzerland, France, England, Slovenia, Portugal, Spain, Germany, Poland, Ukraine, Georgia, and Armenia. Tithonian of Czech Rep. and Poland. This species has been also described from the Lower-Middle Jurassic (Toarcian–Lower Bajocian) of Iran (Pandey and Fürsich, 2006) and from the Oxfordian (Bajocian; Schlögl *et al.*, 2006) from the Slovak part of the Pieniny Klippen Belt (Morycowa & Mišik, 2005). It is also described from the Lower Cretaceous (Aptian) in Greece (Baron-Szabo & Steuber, 1996).

Thecosmilia dichotoma Koby, 1884
Fig. 8B–D

non 1826. *Lithodendron dichotomum* Goldfuss: p. 44, pl. 13, fig. 3.
v1884. *Thecosmilia* ? *dichotoma* Koby: Koby, p. 175, pl. 46, figs 4–8.
v1966. *Thecosmilia dichotoma* Koby: Roniewicz, p. 212, pl. 12, fig. 3a, b.
1974. *Thecosmilia dichotoma* Koby: Morycowa, p. 466, pl. 5, fig. 1 (with synonymy).
1976b. *Thecosmilia dichotoma* Koby: Eliášová, p. 169, pl. 1, fig. 2.
1985. *Thecosmilia dichotoma* Koby: Rosendahl, p. 47, pl. 1, fig. 7.
1990. *Thecosmilia* sp.: Eliášová, p. 120, pl. 2, fig. 2.
1991. *Thecosmilia dichotoma* Koby: Lauxmann, p. 149, pl. 6, fig. 10.
1991. *Thecosmilia dichotoma* Koby: Lebanidze, p. 21, pl. 7, fig. 2a, b.
1997. *Thecosmilia dichotoma* Koby: Turnšek, p. 204, pl. 204, figs a-d.
2005. *Thecosmilia dichotoma* Koby: Mišik & Morycowa, p. 424; figs 6.1–3 .
2006. *Thecosmilia dichotoma* (Koby): Pandey & Fürsich, p. 51–52, pl. 1, fig. 5 (with additional synonymy).

Material and measurements (in mm):
(Thin section No. 3/3c with *T. dichotoma* and *Ironella giseldonensis* Starostina et Krasnov).

Well name	Depth in metres	Specimen and thin section numbers	d cor	cor-cor	S	den c	den tr
Swarzów 4	677.8–682.2, I	3/3 (3/3a–c)	8–14	1.5–10	36–*ca.* 60	4–5/2	6–7/2

Remarks: Dendroid-phaceloid corallum visible in polished and thin limestone sections. Corallites subcircular and oval with thin radial elements belonging to three and occasionally four size orders, of which about 12 reach the centre. Montlivaltiid type micro-mo rphology of radial elements well preserved (Fig. 8D).

On account of the corallite measurements and number of radial elements, the Carpathian Foreland specimens correspond to *T. dichotoma* described in Koby (Koby, 1884; not *Lithodendron dichotomum* Goldfuss). The specimens under this name were frequently described from the Upper Jurassic of Europe (*cf.* Geyer, 1954; Roniewicz, 1966; Turnšek, 1973; Morycowa, 1974; Eliášová, 1976b; Rosendahl, 1985, Mišik & Morycowa, 2005). It is known, however (Lathulière, 1989a, p. 61), that this species name is invalid, as it is a secondary homonym. In this paper, the specimens corresponding to Koby's corallum features are still described as *T. dichotoma*.

Most similar to *T. dichotoma* Koby is *Thecosmilia pinguis* Eliášová (Eliášová, 1976b; Roniewicz, 2008), the species differing from *T. dichotoma* only in thicker and less dense radial elements (den s = 6–7/5 mm in *T. pinguis*).

Distribution: *Thecosmilia dichotoma* Koby is common in the Up-

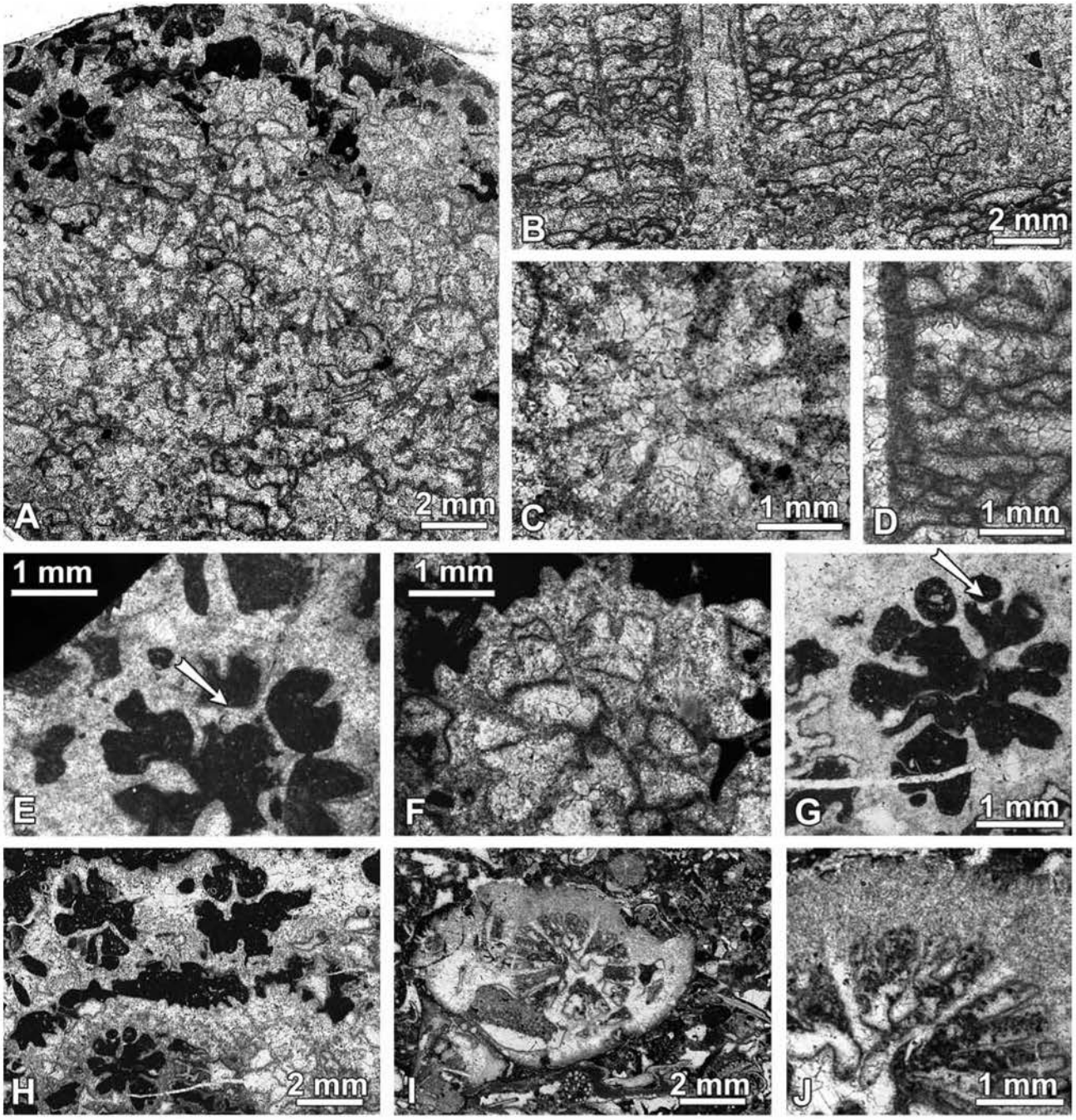

Fig. 7. **A–G** – *Ironella giseldonensis* Starostina et Krasnov: A – fragment of colony in transverse thin section (No. 3/2a); B, D – longitudinal thin section (No. 3/2b) showing intercorallite parts with small, abundant vesicular dissepiments between which extended thick subtabuloid elements occur; C, E, F – enlarged corallites from Fig. A showing costo-septa, including thick costae C1 and C2 and some lonsdaloid-like septa (arrow – Fig. E). G – enlarged corallites from thin section No. 3/3c showing lonsdaloid-like septum (arrow); H – transverse thin section (No.3/3c) of colony fragment; **I, J** – *Tiaradendron* sp.: I – transverse thin section (No. 29/1a) of corallite showing septa arranged in regular hexameral symmetry; J – detail of the same corallite; well visible septa S1 to S3 size orders

per Jurassic of Europe. Upper Oxfordian–Kimmeridgian of Switzerland, Portugal, Germany, Poland, Slovenia, Ukraine, and Georgia; in Tithonian of the Czech and Polish Outer Carpathians. It is also noted in the Lower Jurassic of Iran (Pandey & Fürsich 2006), the ?Upper Jurassic of Slovakia (Morycowa & Mišik, 2005) and in the Lower Cretaceous (Aptian) of Central Greece (Baron-Szabo & Steuber, 1996). It seems likely, however, that some non-Upper Jurassic specimens identified as *Thecosmilia dichotoma* require a closer comparison with typical specimen from Koby's collection (Koby, 1884).

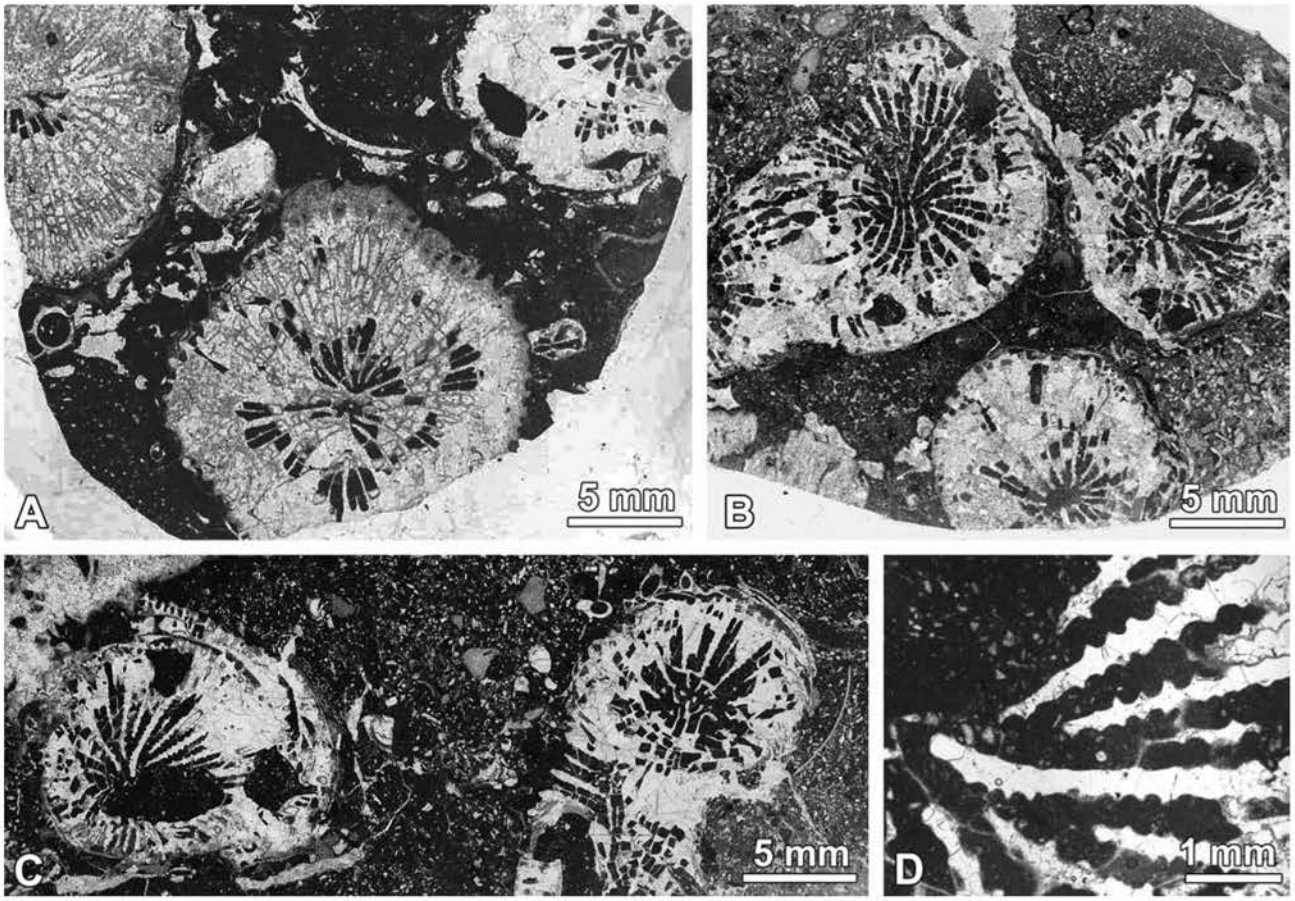

Fig. 8. **A** – *Thecosmilia trichotoma* (Goldfuss): transverse thin section No. 21a. **B–D** – *Thecosmilia dichotoma* Koby: B – transverse thin section (No. 3/3a); C – the same phaceloid corallum (thin section No. 3/3b); D – detail from Fig. C showing montlivaltiid micromorphology of septa

Genus *Complexastrea* d'Orbigny, 1849
Type species: *Confusastrea subburgundiae* d'Orbigny, 1849

Complexastrea burgundiae (de Blainville, 1830)
Fig. 9A–D

1840–1847. *Astrea Burgundiae* Blainville: Michelin, p. 106, pl. 24, fig. 4.
1885. *Confusastrea Burgundiae* Blainville: Koby, p. 261, pl. 76, fig. 1 (with synonymy).
1913. *Confusastrea burgundiae* Blainville: Speyer, p. 219.
1960. *Complexastraea burgundiae* (de Blainville): Roniewicz, pp. 461–462, pl. 5, figs 1, 2.
2005. *Complexastrea burgundiae* (de Blainville): Radwański & Roniewicz, p. 101, pl. 2, fig. 1a, b.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d cor	c-c	S	den s	den lateral trab.	den diss
Swarzów 4	662.0–667.3, V	2/2 (2/2a, b)	55×80; 80	18–23	18–23	36–46	3–4/5	4/2	6–7 (8)/5
Swarzów 3	805.3–811.3, V	18 (18a, b)	80×80; 70	*ca* 20	17–20		4–5/5	4/2	6–7 (8)/5

Remark: Large massive colonies. Corallite subcircular and suboval. Radial elements from 36 to *ca.* 50 represent four size orders and occasionally five, 12–20 of which reach the central zone (Fig. 9A, C). In the radial elements (Fig. 9D), traces of montlivaltiid type microstructure are visible (*cf.* Gill, 1970; Gill & Lafuste, 1971).

The specimens from the Polish Carpathian Foreland do not differ from those described by Koby (1885), Roniewicz (1960), and Radwański and Roniewicz (2005).

Distribution: *C. burgundiae* occur in the Upper Oxfordian and Lower Kimmeridgian of Europe (France, Switzerland, Germany, Poland).

Complexastrea magna sp. n.
Fig. 10A–E

Holotype: UJ 217P 32/1, Fig. 10A–E
Type level: Upper Jurassic; depth: 936.8–942.8 m, IV
Type locality: Swarzów 8 borehole (Polish Carpathian Foreland)
Derivation of the name: *magnus* (lat.). The specific name derives from large corallite diameters.
Diagnosis: Subcircular, suboval corallites with deep calices. Corallite diameters from 18 to 35 mm and distances between their centres from 18 to 35 mm. Costo-septa up to 46, bicuneiform. Density of costo-septa in the peripheral part of corallites 3–4 per 5 mm, of trabeculae (corresponding to carinae) 5–8 per 5 mm, and of endothecal elements 3–5 per 5 mm.

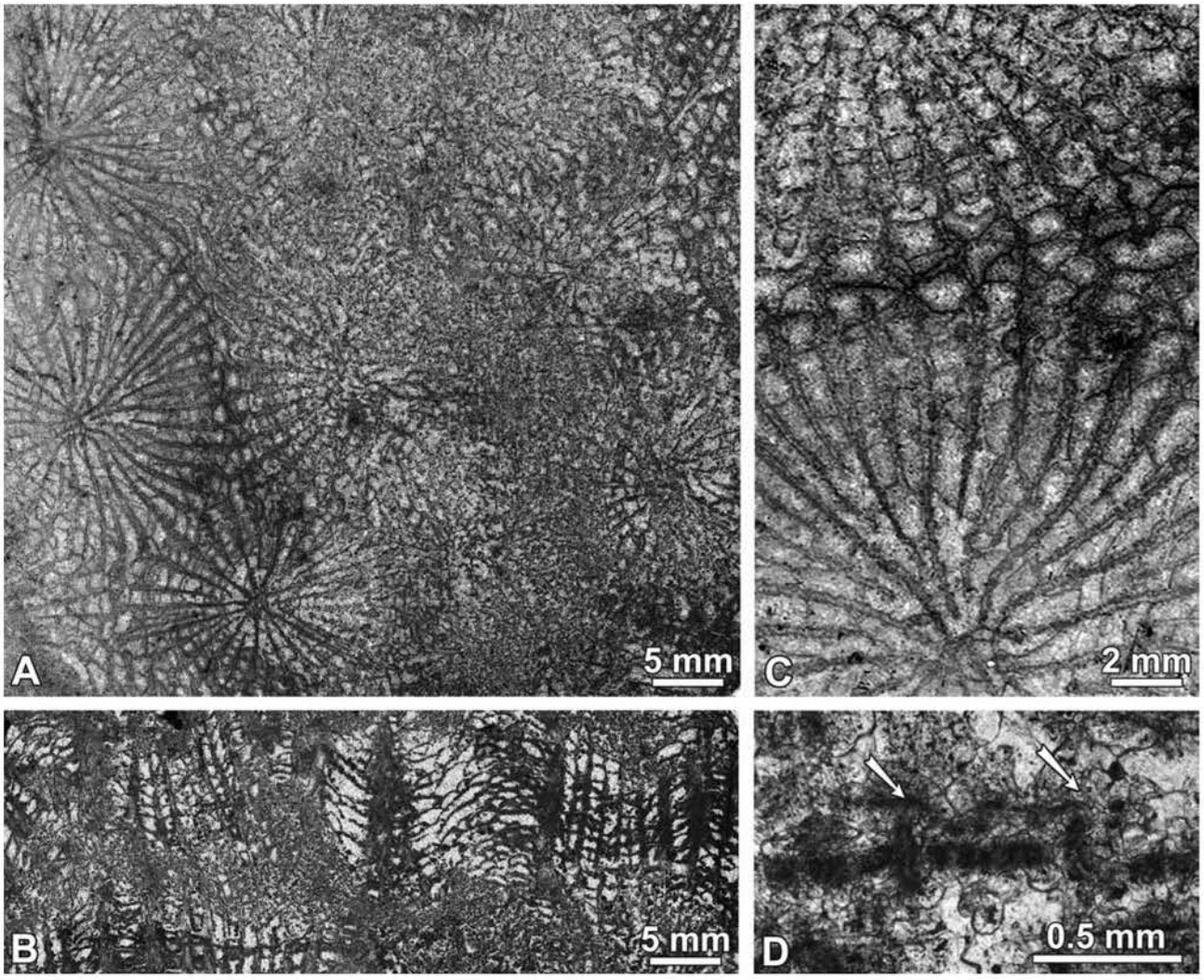

Fig. 9. **A–D** – *Complexastrea burgundiae* (de Blainville): A – colony fragment in transverse section (No. 2/2a); B – longitudinal thin section (No. 2/2b) showing extended, concave dissepiments in corallite central part and vesicular in the peripheral zone; C – enlarged fragment of the peripheral zone of two adjacent corallites showing their non- and subconfluent radial elements as well as numerous dissepiments; D – enlarged detail from Fig. A, showing traces of the main trabeculae and those branching off the main axis, *i.e.* lateral trabeculae (arrows)

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d cor	c-c	S	den s	den tr	den end
Swa-rzów 8	936.8–940.8, IV	32/1 (32/1a–d)	80×80; *ca.* 100	18–35	20–35	32–46	3–4/5	5–8/5	3–5/ 5

Description: Massive astreoid colony. Corallites subcircular, suboval in cross-section. Radial elements compact, thick, bicuneiform, up to *ca.* 50 in number and differentiated in three to four size orders. Twelve to 24 long, subequal septa S1 or S1 and S2 reach the oval central corallite area. The septa of the highest size order shorter, thinner, occurring occasionally. Micromor- phology of lateral sides of septa, visible in transverse thin sections, shows regularly distributed granules (carina section) of density 5–8 per 5 mm. Endotheca composed of concave, subtabuloid elements in the centres and of vesicular ones in peripheral corallite parts. Budding intracalicinal.

Microstructure: The radial element microstructure can be traced on the basis of its preserved vestiges (Fig. 10B, C). The density of the septal lateral trabeculae is 5 to 8 per 5 mm, depending on their position in radial elements. The largest trabeculae occur in the calice border zone.

Remarks: In the dimensions of corallites, *Complexastrea magna* sp.n. is close to *Complexastrea lobata* Geyer from the Kimmeridgian of Spain (Geyer, 1965; d = 15 to 30 mm), but differs from the latter in structure type of corallum, in less numerous radial elements and in less dense endothecal elements (in *C. lobata*: den end. = 13–15/10 mm). On account of the meandroid character of *C. lobata* (with corallites joined in series by valley septa), Morycowa (1974) considered this species as the type species of the new genus *Complexastreopsis*.

The difference between *Complexastrea magna* sp.n. and *Complexastrea burgundiae* (de Blainville, 1830) lies in larger corallite diameters of the former as well as in its thicker radial elements.

In respect of corallite diameters and nearly identical number of radial elements, the specimen presented here is close to *Complexastrea* mg *zolleriana* morphe *major* (Meyer) from the Bajocian of France (Lathulière, 1996, *cf.* pl. 74, figs 3 and 4; pl. 75, figs 1, 4–7). The difference between these species can be, however, seen in the colony structure variability, with subcerioid structure

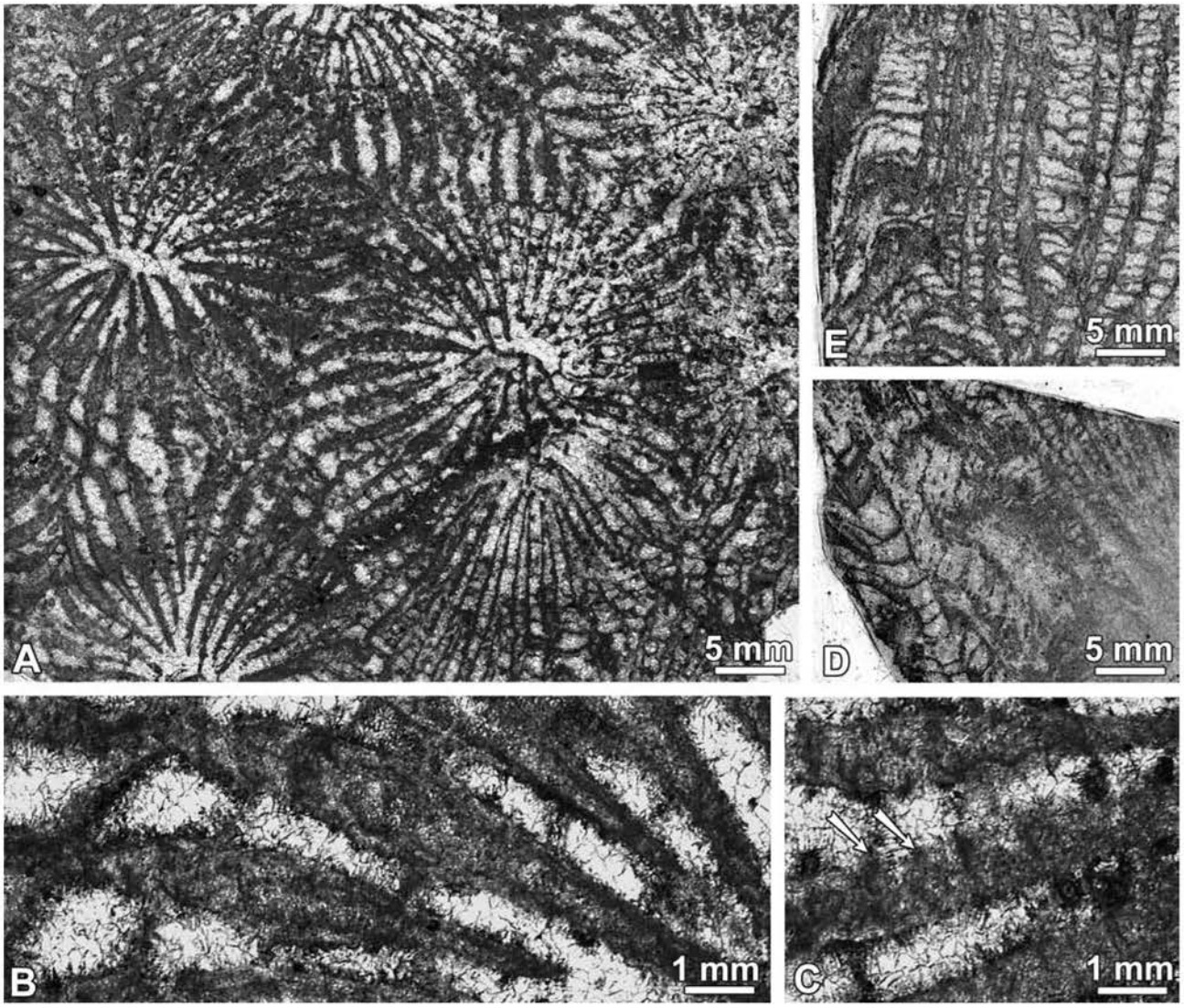

Fig. 10. **A–E** – *Complexastrea magna* sp.n.: A – colony fragment in transverse thin section (No. 32/1a); B, C – enlarged fragments of Fig. A, showing bicuneiform form of radial elements (Fig. B) and traces (arrows) of septal trabeculae (Fig. C); D, E – longitudinal thin section (No. 32/1b) showing density of endothecal elements

and in partly detached corallites in the peripheral part in the latter. A more detailed microstructural comparison of the latter with the Upper Jurassic specimen described from the Carpathian Foreland would be useful.

Complexastrea dabroviensis sp. n.
Fig. 11A–C

Holotype: UJ 217P 5/2, Fig. 12A–C.
Type level: Upper Tithonian, depth: 677.9–682.2, III.
Type locality: Swarzów 4 borehole (Polish Carpathian Foreland).
Derivation of the name: The specific name derives from Dąbrowa Tarnowska town.
Diagnosis: Subcircular corallites in cross sections of diameters from 5 to 7 mm and distances between their centres 5–7 (8) mm. Costo-septa 32 to 56, arranged in three or four size orders. The density of costo-septa in the peripheral part of corallites is 4 per 2 mm, of endothecal elements 4–5 per 2 mm and of lateral trabeculae (corresponding to carinae) 7–8 per 2 mm.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d cor	c-c	S	den s	den tr	den diss
Swarzów 4	677.9–682.2, III	5/2 (5/2a–d)	80×60; max 15	5.0–7.0	5–7 (8)	32–56 S1-S4	4/2	7–8/2	4–5/2

Description: Lamellar astreoid colony. Radial elements generally thick, arranged in three or four irregularly disposed size orders, of which 10 to 14 S1 reach the small central pit. Other septa gradually shorter, depending on size orders. The septa of two first size orders are similar in thickness (th S1=0.30 to 0.35 mm) and those of the higher orders are slightly thinner.

Traces of montlivaltiid type of septal microstructure are to be observed (Fig. 11A, B).

Remarks: *Complexastrea dabroviensis* differs from other Upper Jurassic species of the genus *Complexastrea* in considerably smaller corallite diameters.

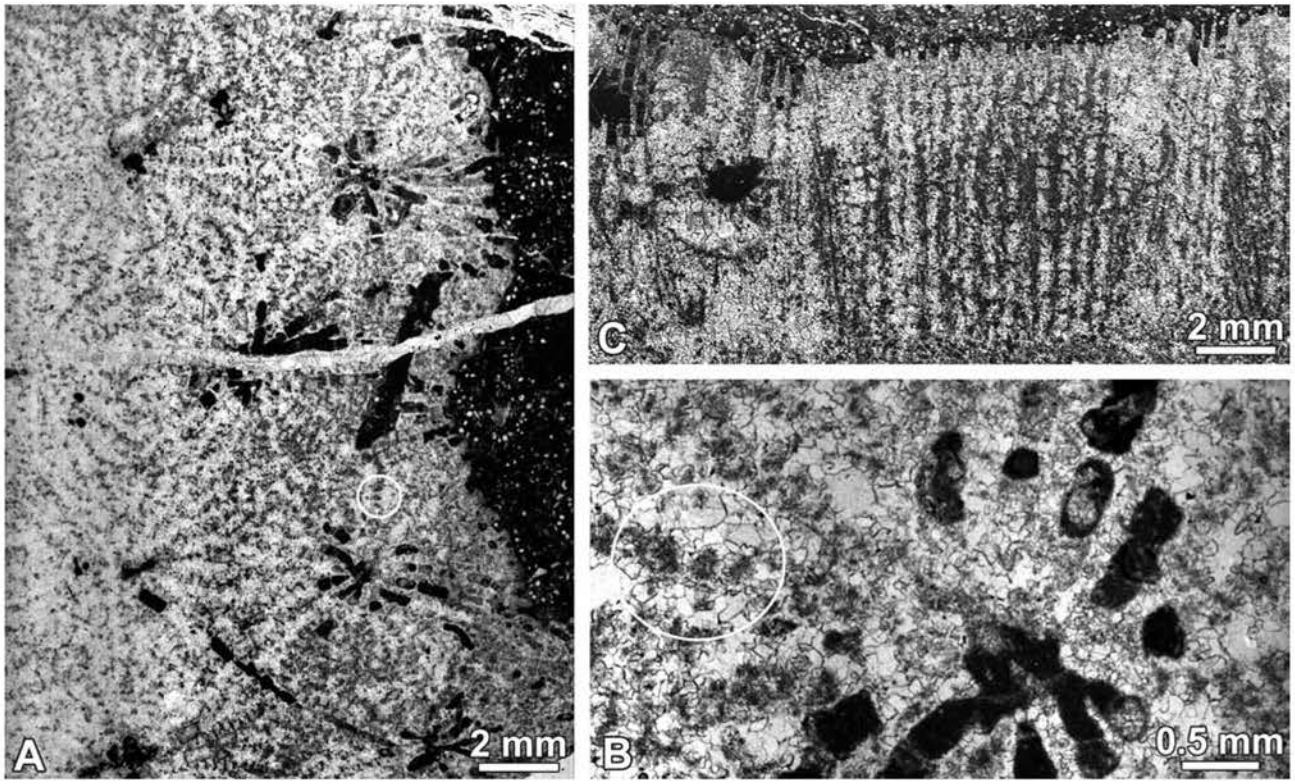

Fig. 11. **A–C** – *Complexastrea dabroviensis* sp.n.: A – fragment of colony in transverse thin section (No. 5/2a); B – enlarged corallite from Fig. A. Traces of montlivaltiid type of microstructure are circled in Figs A and B; C – fragment of lamellar colony in longitudinal thin section (No. 5/2b)

The species closest to *Complexastrea dabroviensis* sp.n. is *C. carpathica* Morycowa (1974) from the Tithonian of the Polish Outer Carpathians (from exotic boulder). *Complexastrea dabroviensis* differs, however, from the latter in smaller corallite diameters (in *C. carpathica*: c-c = 7–12 (13) mm), in thicker septa (in *C. carpathica*: thickness S1 = 0.15–0.20 (0.30) mm) and in considerably denser lateral trabeculae (in *C. carpathica*: den trab = 4–6 per 2 mm).

Genus *Clausastrea* d'Orbigny, 1849
Type species: *Clausastrea tessellata* d'Orbigny, 1850

Clausastrea sp.

Material and measurements (in mm):

Well name	Depth in metres	Thin section number	d	c-c	S	den s	den tr
Swa-rzów 4	760.6–766.7, I	(11a)	9×10	3–5	*ca.* 14	4–5/2	5–6/1

Remarks: A small fragment of the thamnasterioid colony. On the basis of the macro-and micromorphology of the skeleton, this corallum is included in the genus *Clausastrea* d'Orbigny. The state of preservation does not allow for specific identification.

Family Isastraeidae Alloiteau, 1952
Genus *Isastrea* Milne Edwards et Haime, 1851
Type species: *Astrea helianthoides* Goldfuss, 1826

Isastrea helianthoides (Goldfuss, 1826)
Fig. 12A–C

part. 1826. *Astrea helianthoides* Goldfuss: p. 65, pl. 22, fig. 4a.
1973. *Isastraea helianthoides* (Goldfuss): Babaev, pp. 102-104, pl. 9, fig. 2.
1980. *Isastraea helianthoides* (Godfuss): Liulieva & Permiakov, p. 111, pl. 34, figs 2, 3.
1982. *Isastrea helianthoides* (Godfuss): Bendukidze, p. 58, pl. 13, fig. 5; pl. 18, figs 3, 4.
1990. *Isastraea helianthoides* (Goldfuss): Errenst, pp. 193-194, pl. 11, fig. 2a–c (with complementary synonymy).
1991. *Isastrea helianthoides* (Goldfuss): Lauxmann, pp. 154-155, pl. 7, figs 4, 5.
1993. *Isastrea helianthoides* (Goldfuss): Pandey & Fursich, p. 54, pl. 14, figs 4, 5.
1993. *Isastrea helianthoides* (Goldfuss): Bertling, pp. 94-95, pl. 2, figs 3, 4.
1994. *Isastraea helianthoides* (Goldfuss): Eliášová, p. 67, pl. 1, fig. 2.
1994. *Isastrea helianthoides* (Goldfuss): Liao & Xia, p. 165, pl. 47, figs 4-16.
1997. *Isastrea helianthoides* (Goldfuss): Kołodziej, p. 84, pl. 15, fig. 2.
1997. *Isastraea helianthoides* (Goldfuss): Turnšek, p. 107, pl. 107 fig. 1a-e.
2005. *Isastrea helianthoides* (Goldfuss): Morycowa & Mišik, p. 426, figs 7.6, 7.7.

Material and measurements (in mm):

Well name	Depth in metres	Thin section number	D: H	d	c-c	S	den s	den tr
Swa-rzów 10	742.1–746.3, IV	40/2 (40/2a, b)	40×80; 70	4.5–8.0	4.0-8.0	32–48	4-5/2	*ca.* 10/2

Remarks: Sublamellar, cerioid colony corresponds to *Isastrea*

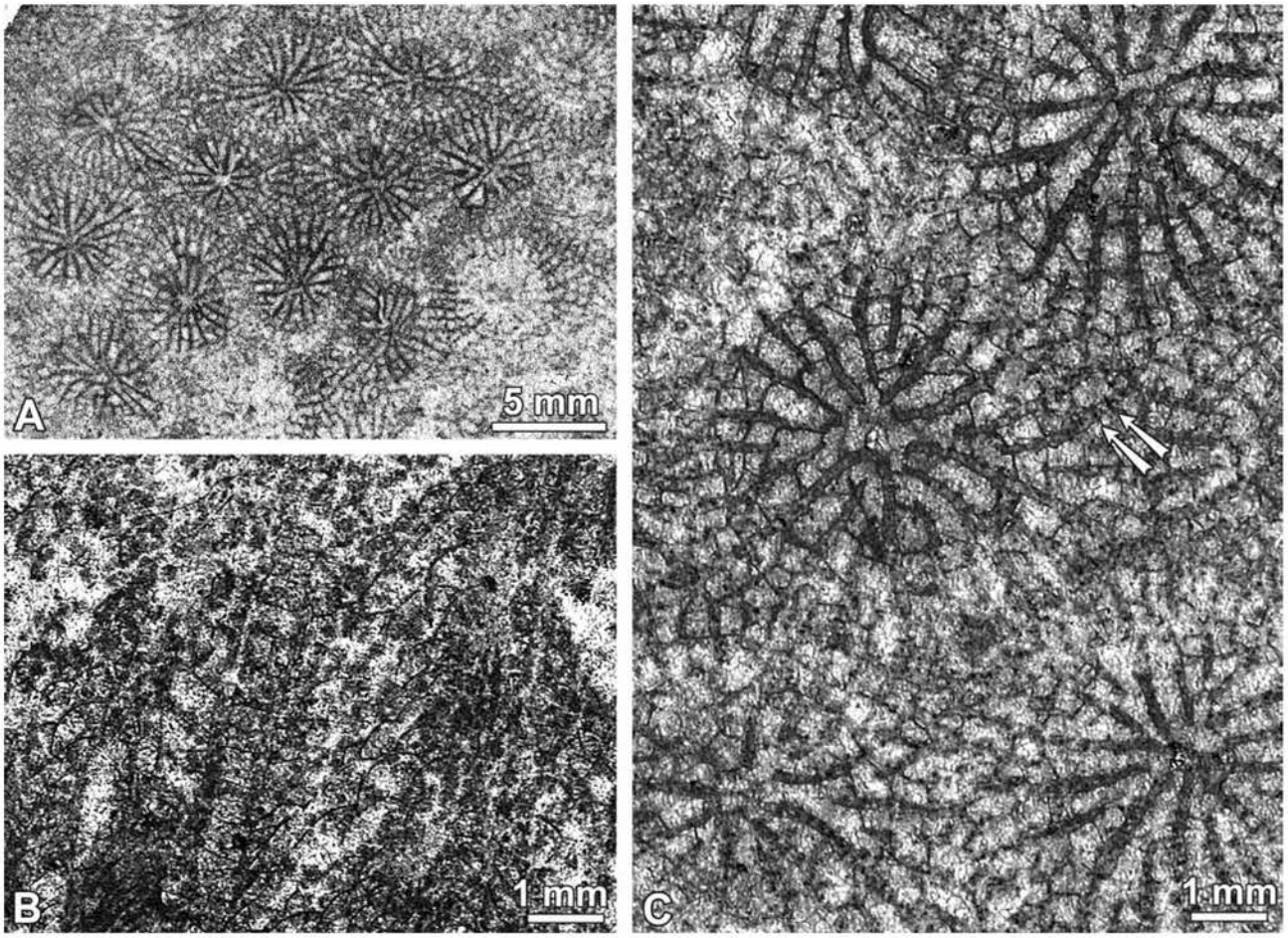

Fig. 12. **A–C** – *Isastraea helianthoides* Goldfuss: A – colony fragment in transverse thin section (No. 40/2a); B – longitudinal-tangential section of corallite (thin sction No. 40/2b) showing small inclined dissepiments in the wall zones of corallites and flat, large ones in central part; C – enlarged fragment from Fig. A, showing regular polygonal corallite connected by thin septo-paratheca. Traces of septal microstructure and micromorphology can be observed (arrows)

helianthoides (Goldfuss). It does not differ from those known in the Upper Jurassic of Europe (*i.a.* Koby, 1885; Geyer, 1955a; Roniewicz, 1966; Turnšek, 1997; Errenst, 1990. It differs from the specimen described from Moravia in denser septal trabeculae (Eliášová, 1994; den tr=6-7/2).

Distribution: The species is common in the Upper Jurassic of Europe and Asia. Oxfordian–Kimmeridgian of France, England, Germany, Spain, Poland, Romania, Slovenia, Czechia (Moravia of Lower/Upper Oxfordian boundery interval), Ukraine, Georgia, ?Armenia, Azerbaijan as well as from the Upper Jurassic in China (Tibet). Tithonian of the Polish Outer Carpathians. Recently, this species has been described from the Lower Callovian of Iran (Pandey & Fürsich, 2003) and from the ?Late Bajosian (age of coral-bearing limestone according to Schlögl *et al.*, 2006) from the Slovak part of the Pieniny Klippen Belt (Morycowa & Mišik, 2005).

Isastrea bernensis Etallon, 1864
Fig. 13A–E

1864. *Isastrea Bernensis* Etallon: Thurman & Etallon, p. 392, pl. 55, fig. 12.
1885. *Isastrea Bernensis* Etallon: Koby, p. 275, pl. 82, figs 1–4.
1888. *Isastraea bernensis* Etallon: Solomko, pp. 165–167, pl. 4, fig. 4.
1973. *Isastraea bernensis* Etallon: Babaev, pp. 102–104, pl. 10, fig. 1
1976. *Isastraea bernensis* Etallon: Roniewicz, p. 67, pl. 13, figs 2a, b, 3.
1964. *Isastrea bernensis* Etallon: Beauvais, p. 166, pl. 17, fig. 1.
1980. *Isastraea bernensis* Etallon: Liulieva & Permiakov, p. 110, pl. 33, fig. 4.
1985. *Isastrea bernensis* Etallon: Rosendahl, p. 48, pl. 5, fig. 7.
1990. *Isastraea bernensis* Etallon: Errenst, p. 193, pl. 11, fig. 1a–c.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	d coralli-tes	c-c	S	den s	den tr
Swarzów 4	677.9–682.2, III	5/1 (5/1a-d)	fragm., 60×45; 60	5–9 (11)	5–10	46–a. 60	4–5/2 +n rudim.	9–10/2
Swarzów 3	811.3–817.3, II	19/2a-b	fragm., 27×35; 24	5.5–8.5 (10)	4.5–8.5	*ca.* 50	5/2	10/2
Swarzów 8	838.1–843.5, VI	27 (27a-b)	30×70; 40	4.5–9.5	6–8.5	42–60	4–5/2	9–10/2
Dąbrówki Breńskie 1	627.6–633.2, III	34/2 (34/2a)	80×85; ca. 50	5–9 (10.5)	5.5–8.5 (8.5)	36–65	5/2	9–11/2

Remarks: Massive cerioid colonies. Corallites with 36 to 65 septa, of which 12 to 14 almost reach the corallite centres. The

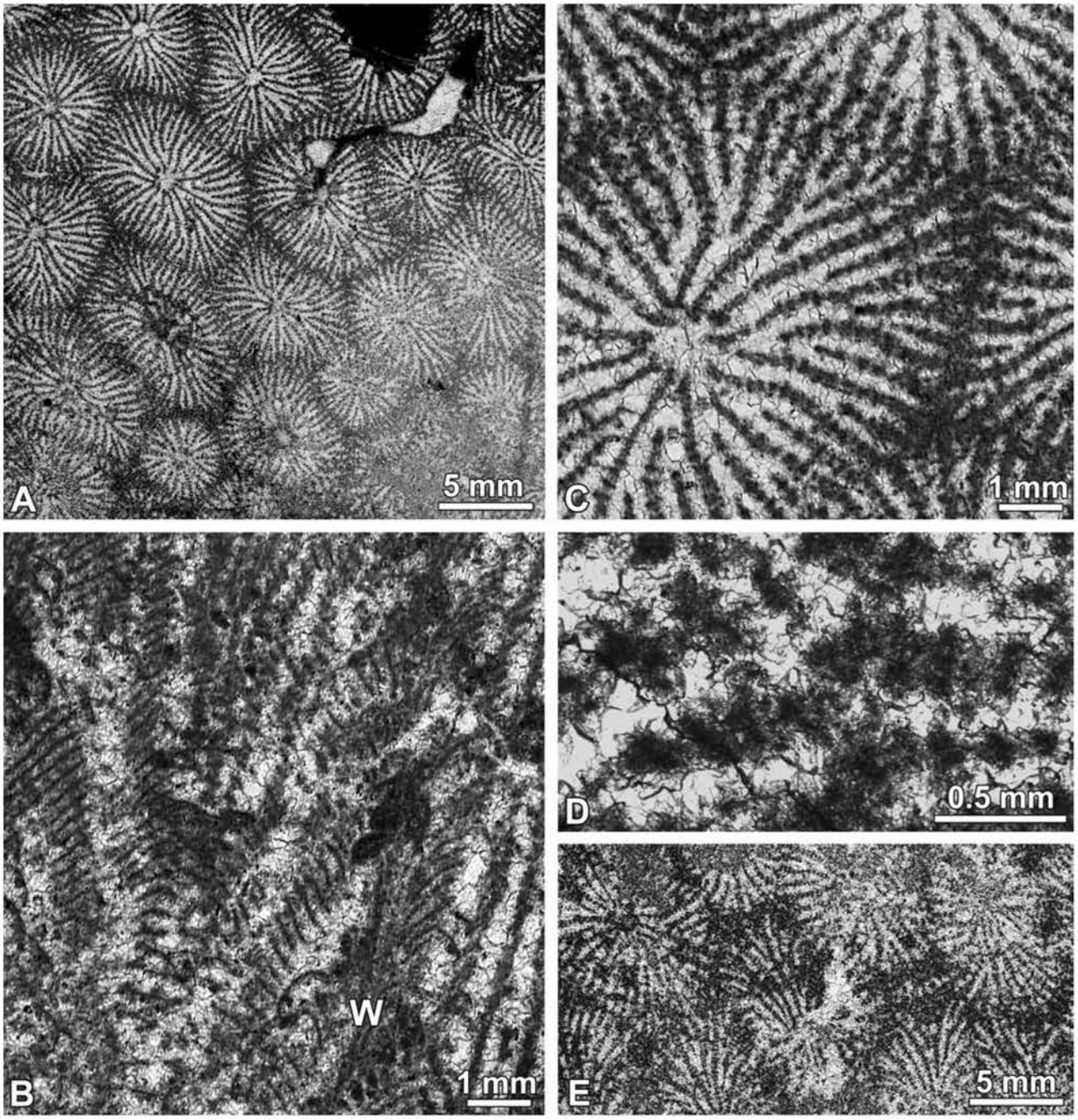

Fig. 13. **A–D** – *Isastraea bernensis* Etallon: A – transverse thin section of colony fragment (No. 34/2a); B – longitudinal-tangential thin section (No. 34/2b) showing the arrangement of trabeculae in radial elements and vesicular dissepiments in wall region (w); C – enlarged fragment from Fig. A, showing arrangement of septa and intercoralite septal parts; D – detail from thin section No. 34/2a, presented on Fig. A. Traces of septal trabeculae (black forms) and septo-paratheca well visibles. **E** – transverse thin section (No. 5/1a) of the same species

shape and diameters of corallites as well as the number of septa and density of trabecular centres (Fig. 13D) indicate their membership into the species *Isastraea bernensis* Etallon (*cf.* Roniewicz, 1982). A slightly different form, on account of its parietal columella, is *Isastrea* cf. *bernensis* Etallon described by Roniewicz (1982) from northern Poland.

It is noteworthy that the skeletal microstructure of the specimens studied here is rather well preserved. In thin longitudinal-tangential section, the trabeculae arranged in series are visible (Fig. 13B). In transverse septal section, regular and densely arranged main trabeculae, with regular branching off lateral ones, perpendicular to the medial septal plane (Fig. 13D) appear. The edges of the axes of the lateral trabeculae form pronounced granules on the septal flank, which merge to form subvertical carinae. Wall thin, formed by bent peripheral septal edges, without additional synapticular elements.

Distribution: Upper Oxfordian-Kimmeridgian of France, Switzerland, Portugal, Spain, Romania, Poland (in Pomeranian erratic pebbles: *Isastraea* cf. *bernensis*), Ukraine, and Azerbaijan. Upper Jurassic of Germany and Ukraine.

Table 2

Comparison of dimensions of the Upper Jurassic *Isastrea bernensis* Etallon given by some authors

Species	d	c-c	S	den S	den tr	Authors
I. bernensis	5 (6)		averaged value 36			Thurmann & Etallon, 1864
I. bernensis	3–9		36–55	10–11/5		Koby, 1885
I. bernensis	5–10	3–9	25–45	4–5/2		Beauvais, 1964
I. bernensis	7–11	7–9	50–68		13–15/2 (5–6/1: pl. 13, fig. 3)	Roniewicz, 1976
I. cf. *bernensis*	6.5–8.0	6–9	50–60	12/5	10/2	Roniewicz, 1982
I. bernensis	6–10	6–8	50–70	12–13/5		Rosendahl, 1985
I. bernensis	(4)5×6–7x10	5–10	44–58		12/2	Errenst, 1990
I. bernensis	4.5–10 (11)	4.5–8.5 (10)	46–64	10–12/5	10–11/2	this paper

Family FAVIIDAE Gregory, 1900
Myriophyllia d'Orbigny, 1849
Type-species: *Meandrina rastellina* Michelin, 1943

Myriophyllia rastellina (Michelin, 1843)
Fig. 14C

1843. *Meandrina rastellina*: Michelin, p. 99, pl. 1, fig. 7.
1850. *Myriophyllia rastellina*: d'Orbigny, bd. II, p. 38.
1964. *Myriophyllia rastellina* (Michelin): Beauvais, pp. 151–152, pl. 14, fig. 3, text-fig. 33a–c.
1976. *Myriophyllia rastellina* (Michelin): Morycowa & Moryc, p. 248, pl. 9, fig. 1.
1977. *Myriophyllia rastellina* (Michelin): Papojan, p. 36, pl. 2, fig. 3.
1990. *Myriophyllia rastellina* (Michelin): Errenst, p. 197, pl 12, fig. 1a–d (with synonymy).

Material and measurements (in mm):

Well name	Depth in metres	Specimens and thin section numbers	D; H	width of series	c-c	den s	S
Swa-rzów 4	702.1–709.1, II	6/2 (6/2a)	15×35; 14	4.5–5.5	4–5	7–8/5	12–24
	760.5–765.7, I	12/1 (12/1a)	15×20; 15	4.5–6	5–6 (7)	6–7/5	(6) 10–12
	760.6–766.7, I	12/2 (12/2a)	20×45; 20	5.0–8.0	4–7	5–7/5	12–18

Remarks: Thin-lamellar, meandroid colonies. Series straight and sinuous. Corallite centres subdistinct with 6–8 septa S1 and thinner and slightly shorter S2. Rarely very short and thin septa S3 occur. Columella, valley-septa, septotheca and endotheca typical of this taxon.

It needs to be mentioned that the specimen No 12/2 differs slightly from the typical forms (Koby, 1881 and neotype designated by Beauvais, 1964) in the larger width of series (from 5 to 8 mm). This coral, identified as *M. rastellina* (Michelin), was illustrated in Morycowa and Moryc 1976 (pl. 9, fig. 1). It is close to the form described from the Upper Oxfordian of the Holy Cross Mts. (Roniewicz, 1966). The series width in the latter is 4.5–7.5 mm. The differences may be due to intraspecific variability.

Distribution: Upper Oxfordian–Lower Kimmeridgian of France, Spain, Portugal, Switzerland, Germany, Poland, Romania and Armenia.

Family DERMOSMILLIIDAE Koby, 1889
Genus *Dermosmilia* Koby, 1884
Type species: *Dermosmilia crassa* Koby, 1884

Dermosmilia sp.
Fig. 14D, E

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D	cor-cor	S	den c
Swarzów 4	677.8–682.2, II	(4/2a, b)	8×10	11-20	*ca.* 50 (S1-S3)	3-5/2

Remarks: Corallum dendroid examined only in cross sections. In corallite parameters, the coral resembles the Upper Jurassic *Dermosmilia simplex* Koby (Koby, 1889; 1904–1905; Beauvais, 1964), however, differs from it in less numerous septa and less dense costae (den c in Koby, 1889: 20 per 5 mm; in Koby, 1904–1905: 16–18 per 5 mm; in Beauvais, 1964: 5–8 per 2 mm).

Genus *Calamophylliopsis* Alloiteau, 1952
Type-species: *Calamophyllia flabellata* de Fromentel, 1861

Calamophylliopsis cervina (Etallon, 1860)
Fig. 14B

1864. *Rhabdophyllia cervina* Etallon: Thurmann et Etallon, p. 380, pl. 54, fig. 1.
1884. *Rhabdophyllia cervina* Etallon: Koby, pp. 191–192, pl. 56, figs 3–7.
1955a. *Calamophylliopsis cervina* (Etallon): Geyer, p. 202.
1991. *Calamophylliopsis cervina* (Etallon): Lebanidze, pp. 31–32, pl. 12, fig. 1a, b, text-fig. 6.
1997. *Calamophylliopsis cervina* (Etallon): Turnšek, p. 26, pl. 26 (with synonymy).

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	H	d	cor-cor	S	den c
Swa-rzów 3	828.5–834.3, II	20/1 (20/1a-g)	*ca.* 100	(3) 5–8 (10)	(1.5) 3–7.0	ca. 50 S1-S3	10–12/5

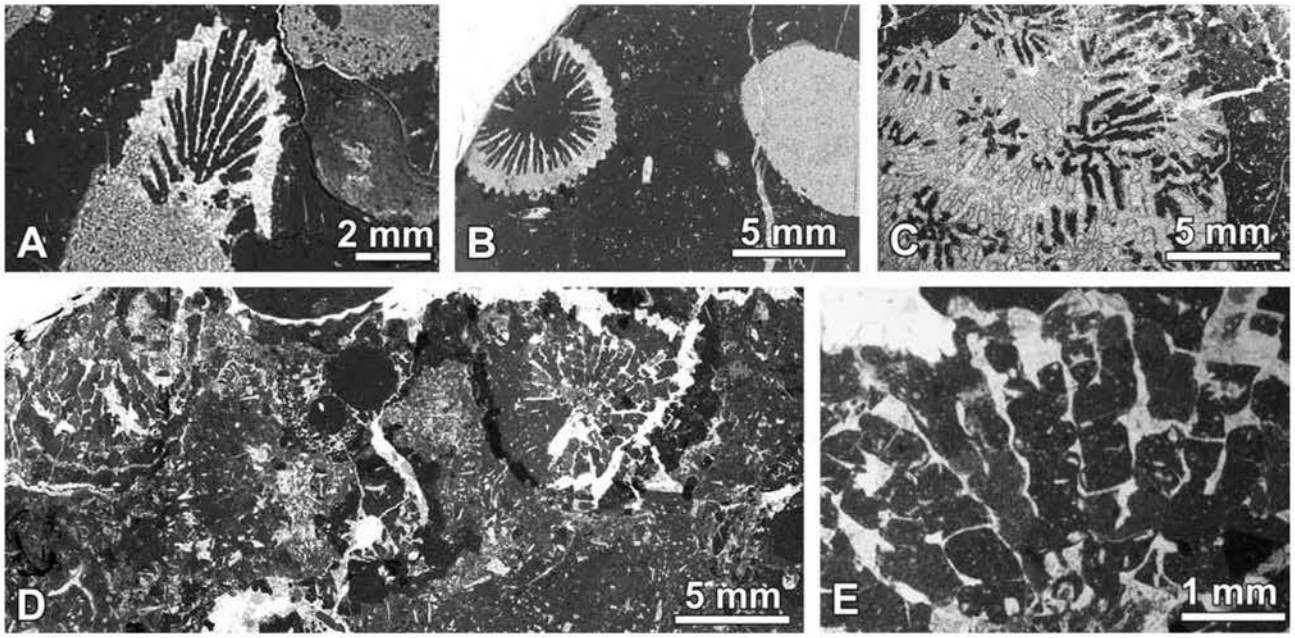

Fig. 14. **A** – *Calamophylliopsis* sp. Corallite from the phaceloid corallum in transverse-oblique section (thin section No. 20/2a). **B** – *Calamophylliopsis cervina* (Etallon): transverse thin section (No. 20a). **C** – *Myriophyllia rastellina* (Michellin). Colony fragment in transverse thin section (No. 6/1a). **D, E** – *Dermosmilia* sp.: D – transverse section of corallites from poorly preserved dendroid corallum (thin section No. 4/2a); E – enlarged corallite fragment showing thin, slightly wavy septa

Remarks: Phaceloid corallum with subcircular to oval corallite lumens and about 50 septa, differentiated into three size orders. Septa S1 (*ca.* 12) approach the centre of the corallite. Lateral septal faces covered with pointed granules. Columella feeble, spongy; wall poorly preserved, endotheca dissepimental. Budding intracalicular (division with indirect linkage).

In dimensions, number and density of radial elements of the corals from the Carpathian Foreland correspond to *C. cervina* (compare, *i.a.*, Ogilvie, 1897; Geyer, 1955a, 1955b; Roniewicz, 1966; Turnšek, 1972).

This species resembles *C. stockesi* (Milne Edwards et Haime, 1851), but differs from it in less numerous radial elements and lower density of costae.

Distribution: Species common in the Upper Oxfordian–Kimmeridgian of Portugal, France, Switzerland, Poland, Romania, Slovenia and Georgia as well as in the Tithonian of the Czech Outer Carpathians.

Calamophylliopsis sp.
Fig. 14A

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	H fragm.	d	den c
Swarzów 3	828.5–834.3, II	20/2 (20/2a)	47	4	ca. 6/2

Remarks: Corallum phaceloid with preserved corallite branches up to *ca.* 40 mm in length. Corallites circular, suboval in thin section, elongated and irregularly shaped, perhaps as a result of process of budding. External part of corallites rather well preserved but their internal parts recrystallized. Radial elements very dense in the wall zone. Endotheca composed of large oblique dissepiments in external corallite parts, flat in the centre.

Suborder FUNGIINA Verrill, 1865
Family TAMNASTERIIDAE Vaughan et Wells, 1943
Genus *Thamnasteria* Lesauvage, 1823
Type species: *Thamnastraea dendroidea* Lamoureux, 1821

Thamnasteria concinna (Goldfuss, 1826)
Fig. 15A–D

1826. *Astrea concinna* Goldfuss, p. 64, pl. 22, fig. 1a.
1966. *Thamnasteria concinna* (Goldfuss): Roniewicz, pp. 232–231, pl. 19, figs 1–3, 4a–b (with synonymy).
1973. *Thamnasteria concinna* (Goldfuss) Babaev, pp. 120–121, pl. 14, figs 1, 4.
1980. *Thamnasteria concinna* (Goldfuss): Liulieva. & Permiakov, p. 78, pl. 1, figs 2, 3.
1982. *Thamnasteria concinna* (Goldfuss): Roniewicz, pp. 158–167, figs 1–5, pls 52–58, pl. 68, fig. 1
1993. *Thamnasteria concinna* (Goldfuss): Bertling, pp. 96–97, pl. 4, figs 1–4.
1997. *Thamnasteria concinna* (Goldfuss): Turnšek, p. 199, pl. 199 (with complementary synonymy).
2005. *Thamnasteria concinna* (Goldfuss): Helm, pp. 110–111, pl. 31, fig. 6.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	c-c in order	c-c between orders	S	den s
Swarzów 4	677.8–682.2, I	? (3/4a–c)	20×40; 7	1.5–2.5	2–2.5 (3)	18–26 (30) (10–12S1-S2+nS3)	9–10/2
Swarzów 4	677.8–682.2, III	5/3 (5/3a–c)	30×30; 45x 37	1.0–2.0	ca. 2,0	14–24	10/2

Well name	Depth in metres	Specimen and thin section numbers	D; H	c-c in order	c-c between orders	S	den s
Swa-rzów 4		5/4 (5/4a, b)	35×40; 15	15-2.0	1.5–2.5 (3)	18, 22	9/2
Swa-rzów 4	741.5–748.3, II	9 (9a, b)	35×.15; 20 27×30	0.8–1.2	0.8–2	16–20 (S1-S2)	10–11/2
Swa-rzów 3	770.2–775.7, II	17/1 (17/1a, b)	fragm. 17–25	0.8–1.5	1.0–2.5	16–26	10/2

Description: Thamnasterioid sublamellar and multicolumnar colonies. Corallites predominantly arranged in series. Radial elements differentiated in two size orders, occasionally septa S3 occur. 6 or 8 to 12 S1 septa reach corallite centres, septa S2 shorter, subequal, and in some specimens slightly thinner than S1. Septal anastomosis present. Columella styliform. Endotheca vesicular.
Microstructure: The traces of septal microstructure preserved in places as regular, simple black points (=calcification centres), of density *ca*. 7 per 0.5 mm.
Remarks: It is worth mentioning that in the Carpathian Foreland some specimens of *T. concinna* occur in the form of bulbous colonies with "multicolumnar growth form" *sensu* Roniewicz (1984). Therefore, they resemble the growth form known from erratic boulders in Poland (Pomerania, Upper Kimmeridgian; Roniewicz, 1984) and from NW Germany (Upper Jurassic; Helm & Elbracht, 1998; compare also Bertling, 1995).

The parameters of *T. concinna* are very close to the Upper Jurassic *Thamnasteria gracilis* (Münster). Some authors go as far as to consider *T. gracilis* as a synonym of *T. concinna* (*i.e.* Becker, 1875 in Becker & Milaschewitsch, 1875-1876; Solomko, 1888; Bertling, 1993). Here, the colony with the corallites arranged in more or less distinct series are included in the species *T. concinna* (*cf.* Koby, 1880–1889; Morycowa, 1964a; Roniewicz, 1966, 1976, 1982; Eliášová, 1990; Errenst, 1990; Turnšek, 1997).
Distribution: The species is common in the Middle Oxfordian–Kimmeridgian of Europe and Western Asia: Portugal, England, France, Switzerland, Germany, Poland, Ukraine, Romania, Slovenia, Georgia, ?Iran, Azerbaijan, and Turkmenistan (Khusanov, 1987; Turnšek, 1997). It is also noted from the Upper Tithonian in the Polish Outer Carpathians (Morycowa, 1974) and in the Upper Jurassic–Lower Cretaceous of the Czech Outer Carpathians (Eliášová, 1990).

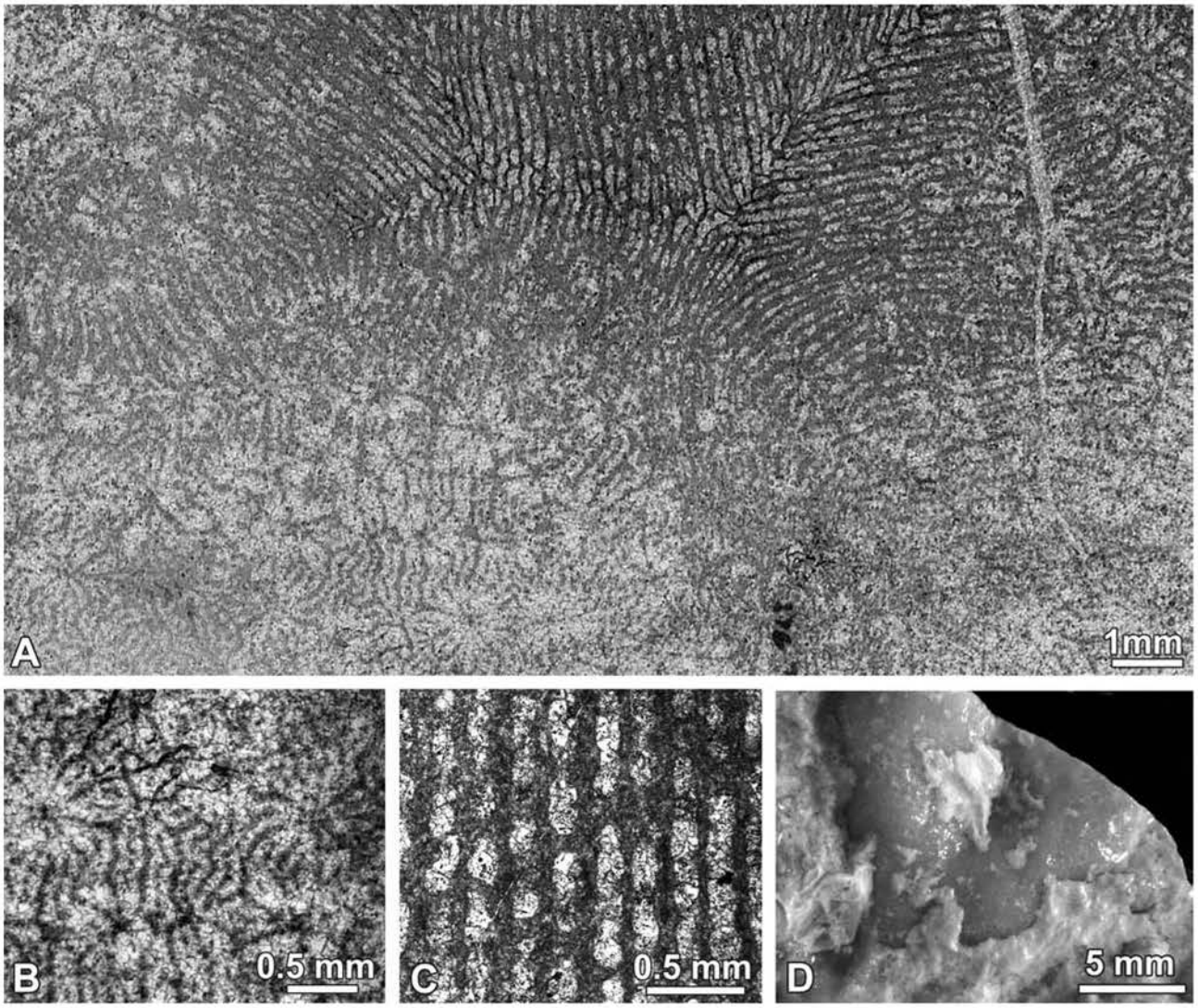

Fig. 15. **A–D** – *Thamnasteria concinna* (Goldfuss): A – multicolumnar colony in transverse, oblique and partly longitudinal sections (No. 9a). In transverse colony part, corallites tend to be arranged in rows; B – detail of thin section presented in Fig. A showing corallites with wavy, in places subparallel, septa; C – longitudinal part of colony; D – multicolumnar corallum in lateral view (specimen No. 5/3)

Thamnasteria sp.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D	c-c in series	c-c between series	S	den s
Swa-rzów 8	861.9–867.4, II	29/2 (29/2a)	fragm. 70×50	2.0–3.5	3.5–5.0	20–*ca.* 40	10–11/2

Remarks: Thamnasterioid colony belonging to the genus *Thamnasteria* but fragmentary preserved specimen does not allow for specific identification. Corallites in the preserved colony fragment arranged in series. Radial elements disposed in three size orders are subequal in thickness. Ten to twelve S1 septa reach corallite centre. Rarely, radial elements of the fourth size order occur and they are slightly thinner than those of the lower orders. Columella small and round.

Suborder MICROSOLENINA Morycowa et Roniewicz, 1995
Family MICROSOLENIDAE Koby, 1889, emended Morycowa et Roniewicz, 1995
Genus *Microsolena* Lamouroux, 1821
Type-species: *Microsolena porosa*, 1821

Microsolena agariciformis Etallon, 1859
Fig. 16E, F

1859. *Microsolena agariciformis*: Etallon, p. 523.
1997. *Microsolena agariciformis* Etallon: Turnšek, p. 127, pl. 127 (with synonymy).
2008. *Microsolena agariciformis* Etallon: Roniewicz, p. 117, fig. 12G.

Material and measurements (in mm):
(In sample No. 6/1, *M. agariciformis* occurs together with *Enallhelia tubulosa* Becker).

Well name	Depth in metres	Specimen and thin section numbers	c-c	den s	S	den tr
Swa-rzów 4	702.1–709.1, III	6/1 (6/1a)	4.5–7 (8)	9–10/2	32–60	5/1

Remarks: Lamellar thamnasterioid colony. Corallites distributed non-serially, partly there is a tendency to form short rows. Calices superficial with small (*ca.* 1.5 mm) central pit. Costo-septa thin, of which *ca.* 20 reach the corallite centres. Columella mono- or polytrabecular, synapticulae and thin flat dissepiments present.

On account of fine and densely distributed radial elements and small and dense septal trabeculae, this form is identified as *Microsolena agariciformis*. However, it differs from the typical form in a slightly lower number of radial elements in corallites (Etallon, 1859: S = 70–80 (96)). There are also descriptions of *M. agariciformis* with less numerous radial elements in other localities (Beauvais, 1964: S = 45; Turnšek, 1972, 1997: S = *ca.* 50).

Distribution: *Microsolena agariciformis* is common in Oxfordian to Tithonian of France, Portugal, Spain, Germany, Poland, Slovenia, Czech Republic, Ukraine, Georgia and Uzbekistan. This species is also noted in the Upper Jurassic–Lower Cretaceous of Czechia and in the Lower Cretaceous (Valanginian) of Bulgaria (Roniewicz, 2008). Discussion on the Lower Cretaceous (Valanginian–Aptian/ Albian) forms showing close similarity to *Microsolena agariciformis* Etallon (described as aff. or cf.) is presented by Morycowa and Masse (2009).

Microsolena exigua Koby, 1887
Fig. 16A–D

1887. *Microsolena exigua* Koby, p. 400, pl. 121, figs 1–2.
1897. *Microsolena exigua* Koby: Ogilvie, p. 230, pl. 11, figs 7, 8.
1964. *Microsolena exigua* Koby: Beauvais, 229, pl. 28, fig. 6.
1976. *Microsolena exigua* Koby: Roniewicz, pp. 104–105, pl. 32, fig. 4a–c.
1985. *Microsolena exigua* Koby: Sikharulidze, p. 49, pl. 23, fig. 1a, b.
1985. *Microsolena exigua* Koby: Rosendahl, p. 5, pl. 1, fig. 12.
1990. *Microsolena exigua* Koby: Eliášová, p. 127, pl. 1, fig. 3.

Material and measurements (in mm):
(In sample No. 16/1, *Microsolena exigua* Koby occurs together with *Protoseris* sp).

Well name	Depth in metres	Specimen and thin section numbers	c-c in series	c-c between series	den s	S	den tr	den pen
Swarzów 3	765.2–770.2, I, 50–60	16/1 (16/1a)	1.0–1.5	1.5–3.0	9–10/2	20–30	5/1	
Swarzów 8	936.8–942.8, IV	32/2 (32/2a–c)	2.5–3.5	2.5–4.5	10/2	24–44	5/1	4/1
Dąbrówki Breńskie 1	702.0–708.6, I	35/1 (35/1a, b)	1.5–4.5	2.5–5.0	8–9/2	20–40	4/1	

Description: Thin lamellar colony. Corallites in places arranged in series. Calice small (1.5–2.0 mm). Septa thin, regularly perforated, differentiated into 3 size orders. Septa S1 approach the axial cavity, septa of higher orders rarely fully developed. Septal pennulae and menianes well developed. Columella small, monotrabecular. Synapticulae and thin dissepiments present.

Remarks: The corals from the Carpathian Foreland correspond to Koby's specimens from the Jura Mts. (Koby, 1887) in all aspects of corallite structure. *Microsolena* aff. *exigua* from the Valanginian of Bulgaria (Roniewicz, 2008) differs from the type specimen in the lower number of septa. *Microsolena exigua* is close to *M. ornata* Koby but differs in having corallites arranged in less distinct series and thinner radial elements (*cf.* Koby, 1887; Turnšek, 1997).

Distribution: Upper Oxfordian–Kimmeridgian of Portugal, France, Switzerland, Romania; Tithonian of Czechia. This species is also noted in the Upper Jurassic–Lower Cretaceous of the Czech Outer Carpathians and in the Hauterivian of Georgia.

Microsolena ornata Koby, 1887
Fig. 17A–F

1887. *Microsolena ornata* Koby: Koby, p. 399, pl. 107, figs 1, 2.
1966. *Microsolena ornata* Koby: Beauvais, p. 1016, pl. 13, fig. 3; pl. 14, fig. 4.
1972. *Microsolena ornata* Koby: Turnšek, 192, pl. 28, figs 3, 4.
1997. *Microsolena ornata*; Koby: Turnšek, p. 130, pl. 130 A–F (with synonymy).
1982. *Microsolena ornata* Koby: Bendukidze, pp. 102–103, pl. 29, fig. 3a, b.
?1985. Microsolena ornata Koby: Rosendahl, p. 56, pl. 6, fig. 4.
2003. *Microsolena ornata*; Koby: Pandey & Fürsich, pp. 107–108, p. 32, fig. 5; pl. 34, figs 1–5.
2006. *Microsolena ornata*; Koby: Pandey & Fürsich, pp. 69–70, pl. 7, figs 3, 5.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	c-c in series	c-c between series	den s	S	den tr	den pen
Swarzów 3	765.2–770.2, I, 50–60	16/1 (16/1a)	1.0–1.5	1.5–3.0	9–10/2	20–30	5/1	

Well name	Depth in metres	Specimen and thin section numbers	c-c in series	c-c between series	den s	S	den tr	den pen
Swarzów 8	936.8–942.8, IV	32/2 (32/2a–c)	2.5–3.5	2.5–4.5	10/2	24–44	5/1	4/1
Dąbrówki Breńskie 1	702.0–708.6, I	35/1 (35/1a, b)	1.5–4.5	2.5–5.0	8–9/2	20–40	4/1	

Remarks: Lamellar colonies with corallites distributed in series. *Microsolena ornata* resembles *M. exigua*, from which it differs in the corallites arranged in distinct series and in thicker and less dense septal trabeculae (den tr in *M. exigua* 4–5 per 1 mm, and in *M. ornata* 3 (4) per 1 mm). It differs in denser radial elements from *M. foliosa* having also corallites disposed in series (in *M. foliosa*, den s=5–6/2; *cf.* Roniewicz, 1976).

Distributions: Callovian of Switzerland. Upper Oxfordian–Kimmeridgian of Slovenia, ?Portugal, and Georgia. This species has also been described from the Lower Bajocian–Kimmeridgian (Pandey & Fürsich, 2003) and the Lower Bajocian of Iran (Pandey & Fürsich, 2006).

Genus *Comoseris* d'Orbigny, 1849
Type species: *Pavonia meandrinoides* Michelin, 1843

Comoseris minima Beauvais, 1964
Fig. 18A–H

1964. *Comoseris minima* n.sp.: Beauvais, p. 237, pl. 30, fig. 5; pl. 31, fig. 1a, b.
1976. *Comoseris minima* Beauvais: Roniewicz, p. 107: pl. 34, figs 4, 5.
1977. *Comoseris minima* Beauvais: Roniewicz, p. 619.
1997. *Comoseris minima* Beauvais: Turnšek, p. 42, pl. 42 (with synonymy).

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	width of series	c-c	den s	S	den tr	den pen
Swarzów 8	829.5–833.8, II	26/2 (26/2a–d)	fragm. 40×55; 20	2–5	2.0–2.5	7/2	12–20	4/1	4/1
Swarzów 8	893.3–898.7, I	30/1 (30/1a–d)	70×80; 35	2–5 (7)	1.5–2.5	7–8/2	14–20	4/1	3–4/1
Swarzów 8	893.3–898.7, VI	31/1 (31/1a, b)	fragm. 20×50;37	1–4	1.0–1.5	6–7/2	*ca.* 12		

Remarks: Incomplete sublamellar colonies. Calices small, mainly

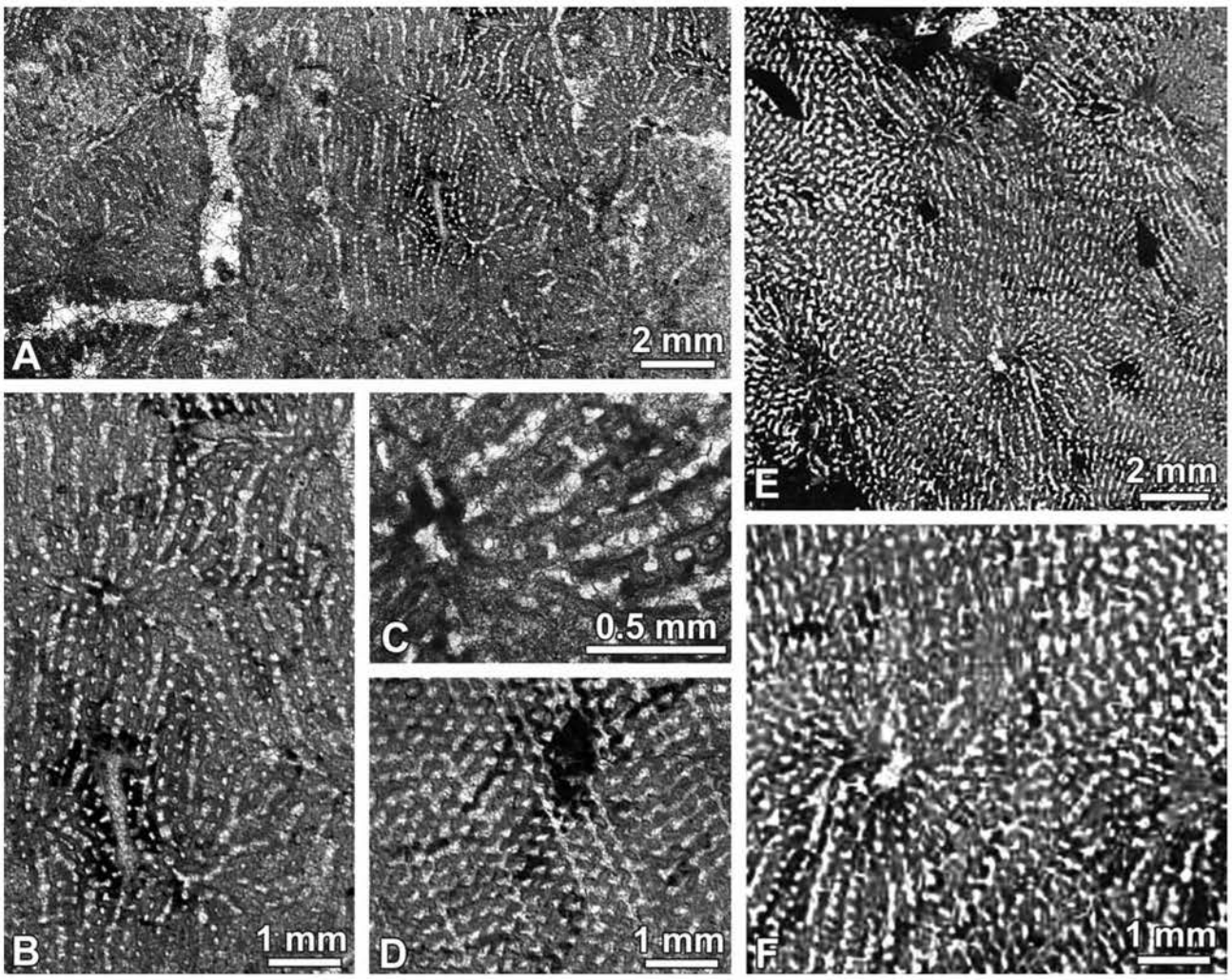

Fig. 16. **A–D** – *Microsolena exigua* Koby: **A** – transverse thin section (No. 32/1a) showing corallites arranged in series; B, C – enlarged fragments of the same thin section, illustrating thin, slightly wavy, regular porous radial elements; D – longitudinal thin section (No. 32/1b) through pennular, porous septa. **E, F** – *Microsolena agariciformis* Etallon: E – transverse thin section (No. 6/2a) showing thin, regular porous, radial elements; F – enlarged fragment of Fig. E

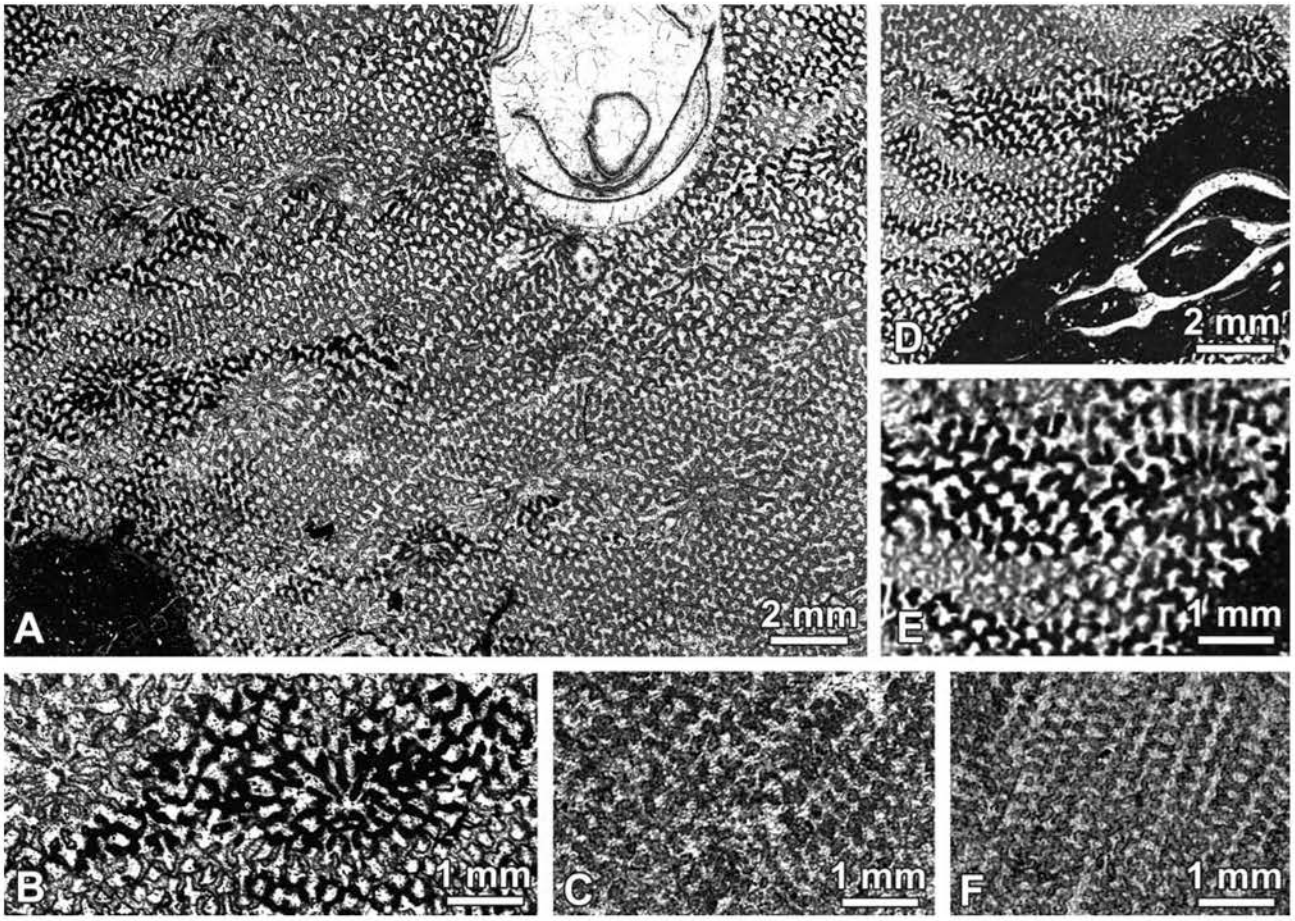

Fig. 17. **A–F** – *Microsolena ornata* Koby: A – fragment of colony in transverse thin section (No. 16/2a) showing corallites arranged in parallel series; B – enlarged fragment of Fig. A showing corallite septa arranged in radial, subregular symmetry; C – longitudinal thin section (No. 16/2b) of pennular radial elements; D – transverse thin section (No. 1b) of colony fragment; E – detail from the same thin section presenting arrangement of septa and small, parietal columella; F – pennular, regularly porous radial elements in longitudinal section (thin section No. 1b)

Table 3

Comparison of some Upper Jurassic *Comoseris*: *Comoseris meandrinoides* Michelin, 1843, *C. minima* Beauvais, 1964 and *Comoseris baltovensis* Roniewicz, 1966

Authors	Species	width of series	c-c in series	den s	S	den tr
Koby, 1887	*Comoseris meandrinoides* Michelin, 1843	5–8	2.5–3.0	18/5 (=7.2/2)	20–24	
Beauvais, 1964	*Comoseris meandrinoides* Michelin, 1843	5–15	2–6	5–6/2		5–7/2
Colony from d'Orbigny collection	*Comoseris meandrinoides* Michelin, 1843	1.5–8.0	1.5–3.0	7–9/2	*ca.* 20	
Beauvais, 1964	*Comoseris minima* nov. sp.	3–8	1–2	7–8/2		7–9/2
Roniewicz, 1966	*Comoseris minima* Beauvais, 1964	2.0–10 (30)	2.0–3.5	16–20/5 (=6.4–8,0)/2	(12) 16–20 (26)	
present paper (averaged value)	*Comoseris minima* Beauvais, 1964	(1.5) 2–5 (7.0)	1.0–2.5	6–8/2	12–20	8–10/2
Roniewicz, 1966	*Comoseris baltovensis* n.sp.	4–6	2,5–3.5	18/5 (=7.2/2)	16–21	4/1

subdistinct, disposed predominantly in monolinear series. Collines long, straight and flexuous. The specimens correspond to *C. minima* Beauvais (Beauvais, 1964) based on a similar width of series, density of corallites in series, density of septa and trabeculae.

The author would like to mention that, while reviewing in the 1970s old scleractinian collections (Muséum d'Histoire Naturelle, Paris) in the d'Orbigny collection, she came across a massive mushroom-like colony, labelled *Comoseris meandrinoides* Michelin, 1843, Rauracien sup.: Châtel-Censoir. This colony has the characteristic flexuous corallite series, 5–8 mm in width and 7–9 radial elements (wall zone) per 2 mm. It would be interesting to compare that specimen with *C. minima* Beauvais. It seems that the difference between these two species lies in the density of septal trabeculae (see Table 3). Moreover, the distances between the corallite centres in *C. minima* are slightly smaller than in *M. meandrinoides*, which, however, may be due to intraspecific variability.

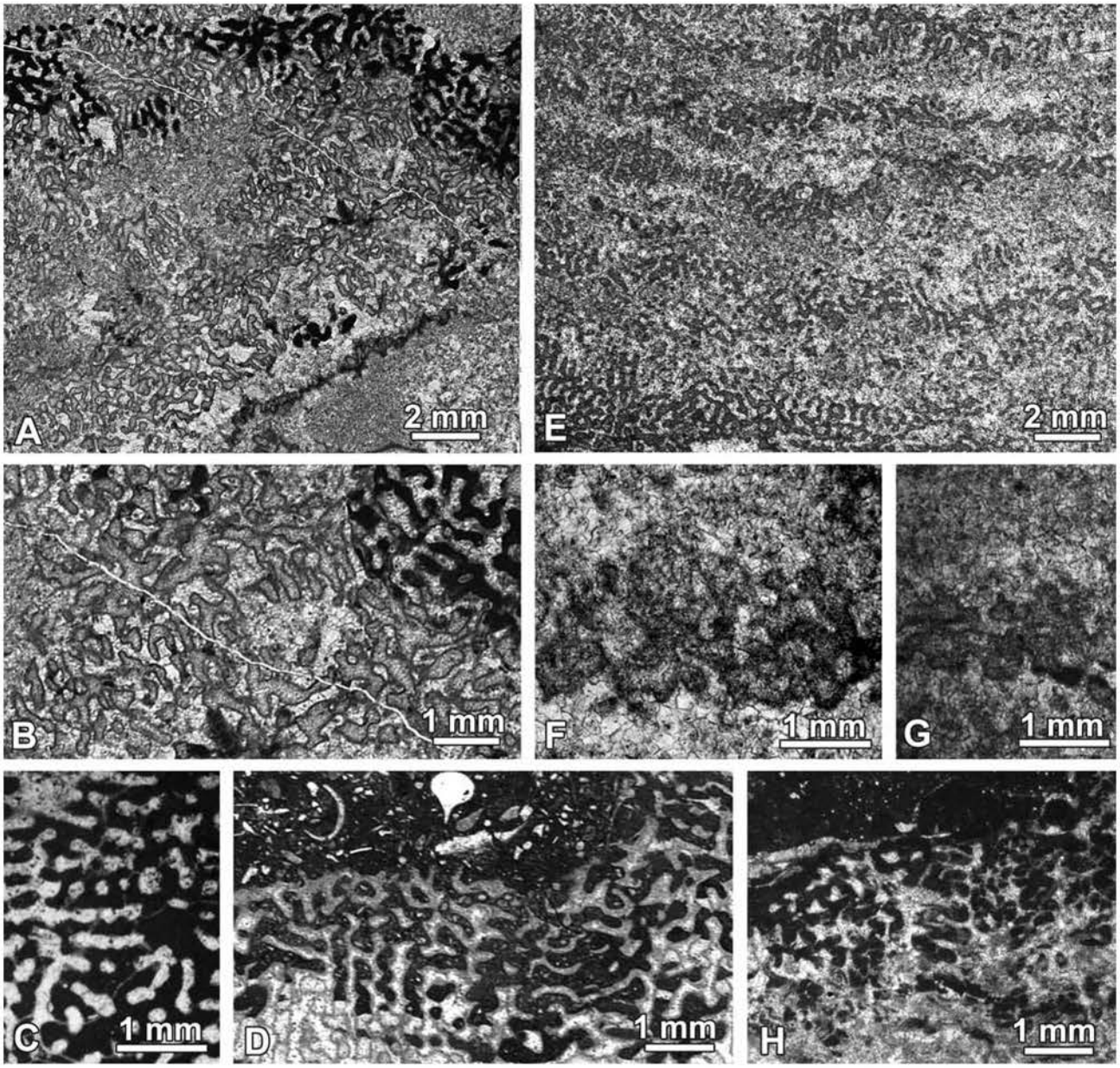

Fig. 18. **A–H** – *Comoseris minima* Beauvais: A – transverse thin section (No. 26/2d) of colony fragment; B – Enlarged part of the same thin section showing series of sub-and indistinct corallite centres; C – enlarged corallite (thin section No. 26/2d) showing regularly porous septa, monotrabecular columella and synapticular wall. D – longitudinal thin section (No. 26/2b) showing pennular, porous radial elements (in places pennules coalescing into menianes) and rare thin dissepiments; E–H – the same species: E – transverse thin section (No. 30/1a); F, G – enlarged fragments from Fig. E showing corallite series. Note sub- and indistint corallite centres; H – longitudinal, partly tangential section (thin section No. 30/1b) showing porous radial elements, in places, pennules coalescing into menianes

Distribution: Oxfordian–Kimmeridgian of Portugal, England, France, Switzerland, Germany, Poland, Slovenia, Romania, Armenia, and Uzbekistan (*cf.* Errenst, 1991; Turnšek, 1997).

Comoseris cf. *interrupta* Koby, 1888
Fig. 19F, G

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	width of series	c-c	den s	S	den tr
Swa-rzów 8	893.3–898.7, III	31/2 (31/2a, b)	2.5–5.5	2.5–3.5 (4.0)	5/2 (13/5)	12–24	3–4/1

Remarks: Fragment of lamellar colony with short (with 3–5 calices), straight, monoseries divided by often interrrupted collines. In places, corallite centres connected with valley septa. Twelve to 24 septa in corallites arranged in series. Septa regularly porous, sub- and nonconfluent in the wall. Septal anastomosis frequent. Columella small, monotrabecular.

In the width of the corallite series, number and density of radial elements and density of septal trabeculae, the coral from the Carpathian Foreland resembles the Upper Jurassic *Comoseris interrupta* Koby (the author's observations of the Koby's specimen presented in 1888, pl. 3, fig. 3).

Comoseris sp.
Fig. 19A–E

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	width of series	c-c in series	den s	S	den trab	den pen
Smęgorzów 2	761.3–766.0, I	45 (45a, b)	50×55; 40	2.5–5.5	2.0–4.5	9/2	16–36	3–4/1	4–5/1

Description: Thick-lamellar colony with corallites arranged in straight, mainly monolinear, series and with low, narrow collines occurring between them in places. Calices small, subcircular, indistinct, less frequently well-marked and joined by valley septum (Fig. 19A). Sixteen to 36 regularly perforated radial elements arranged in two or three size orders. They are thin, equal in thickness; 8 to 16 of them approach the corallite centre. Septa S3 distributed irregularly. Columella monotrabecular. Pennules and menianes well developed. The menianes are slightly inclined from the corallite periphery toward its central zone. Occasionally septosynapticulotheca occur in the collines. Dissepiments thin, extended, rather rare. Synapticulae abundant. Budding intracalicinal.
Remarks: The colonies *Comoseris* sp. 1 show a transition from the genus *Microsolena* toward the genus *Comoseris*. They exhibit a striking similarity in diameter and arranged of corallites to *Microsolena ornata* presented here (Fig. 17A). However, they have been assigned to the genus *Comoseris* on account of the tendency to create a wall between series (Fig. 19E), occasional occurrence of two corallites across series, as well as the presence of monotrabecular columella.

These colonies show some resemblance in narrow series and their arrangement to *Comoseris cesaredensis* Koby from the Kimmeridgian of Portugal (Koby, 1904–1905, pl. 18, fig. 13). However, the species described here differs from *C. cesaredensis* in larger corallite series (in *C. cesaredensis* col-col = 2 mm) and in more numerous septa in corallites (in *C. cesaredensis* S = 20–24).

Comoseris sp. 1 differs from *Comoseris minima* Beauvais in less distinct and mainly straight corallite series and higher density of the radial elements.

Genus *Meandrarea* Etallon, 1859
Type species: *Meandrarea marcouana* Etallon, 1859

Meandrarea gresslyi Etallon, 1864 *sensu* Koby, 1888
Fig. 20A–E

v1888. *Meandrarea gresslyi* Etallon: Koby, p. 408, pl. 109, figs 1, 2 (not fig. 3).
1955b. *Meandrarea gresslyi* Etallon: Geyer, p. 336.
?1964b. *Meandrarea (Michelinaraea) gresslyi* Koby (non Et.): Morycowa, pp. 88–89, pl. 25, figs 3, 4.
1997. *Meandraraea gresslyi* Etallon: Turnšek, p. 121, figs a–f (with synonymy).

Material and measurements (in mm):

Well names	Depth in metres	Specimen and thin section numbers	D; H	col-col	c-c in series	den s	S	den tr	den pen
Swarzów 4	695.3–702.1, III	5B (5B/a)	65×70; 25	3.5–4.5	(1.5) 2–4 (5)	6 (7)/2	10–22	3/1	3/1
Swarzów 3	770.2–775.7, II	(17/2a)	fragm. 25×43	3.5–4.5	2.0–3.5	6–7/2	ca. 20	4/1	

Description: Lamellar colony with narrow, straight, parallel, monolinear calicinal series, separated by low, continuous and interrupted in places, tectiform collines. Calices generally sub- distinct but in places well marked and joined by valley-like septa (Fig. 20A, C). Radial elements porous and pennulate. They are confluent or subconfluent in collines and slightly converging in series, within roundish shallow calice fossa. In places incomplete, probably synapticular, walls (Fig. 20D). Columella monotrabecular, seldom visible. Dissepiments not abundant.
Remarks: *Meandrarea gresslyi* from the Carpathian Foreland does not seem to differ from that described by Koby (1888, pl. 109, figs 1, 3). Some remarks concerning the genus *Meandrarea* Etallon (Thurmann et Etallon, 1864) and the specimens *Meandrarea gresslyi* Etallon presented by Koby (1888) are given in Morycowa and Masse (2009).

The specimen from the Lower Cretaceous of the Polish Outer Carpathians (Morycowa, 1964b, pl. 25, fig. 4, non 3) identified as *Meandrarea (Michelinaraea) gresslyi* Koby (non Etallon) does not differ in dimension from Koby's specimen (Koby, 1888, pl. 109, fig. 1). Perhaps, they differ in skeletal microstructure, but this feature cannot be verified on account of the state of specimen preservation.

Table 4

Measurements (in mm) of the specimen *Meandrarea gresslyi* presented in Koby (1888, p. 48, pl. 109, fig. 1), coll. Koby, hypotypoid No. D4853, Museum of Natural History, Basel (Oxfordian "Corallien blanc", Berner Jura: Caquerelle). Compare also Fig. 20F

D	col-col (collines tectiform)	c-c in series (calices subdistinct)	den s	S	den tr
ca. 30–55×85	(3) 3.5–4.0 (4.5)	((1.5)) 2.0–4.5 (5.0)	5–6/2	12–16 (24)	3/1

Distribution: This species is common from the Oxfordian to Tithonian of France, Switzerland, Spain, Portugal, Romania, Czech Outer Carpathians, Germany, and Slovenia. Lower Cretaceous specimens (Morycowa, 1964b) need comparative study.

Microsolenidae indet.
Fig. 21A–D

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	D; H	c-c in series	c-c between series	den s	S	den pen
Swarzów 8	893.3–898.7, I	30/2 (30/2a–e)	80×80; 50	3–7	6–10	7–8/2 16–17/5	20–40 (60)	6/2

Remarks: Corallum sublamellar, composed of foliaceous laminae. Corallites of varying diameters, with rather small deep central fossa. In peripheral colony, part of corallites arranged in long subcircular and substraight series. In more central zone, they are short and twisted. Radial elements regularly porous (Fig. 21B, D), similar in thickness, arranged in three or four size orders. Corallites in series have *ca.* 20 to 40, rarely up to 60 radial elements. Pennules and menianes well developed. Synapticulae frequent, particularly around calice zone. Dissepiments thin, extended. Columella papillose. Budding of new individuals at the periphery of the adult corallites.
Remarks: On account of pennular, regularly porous radial elements, the specimen agrees with the diagnosis of the Microso-

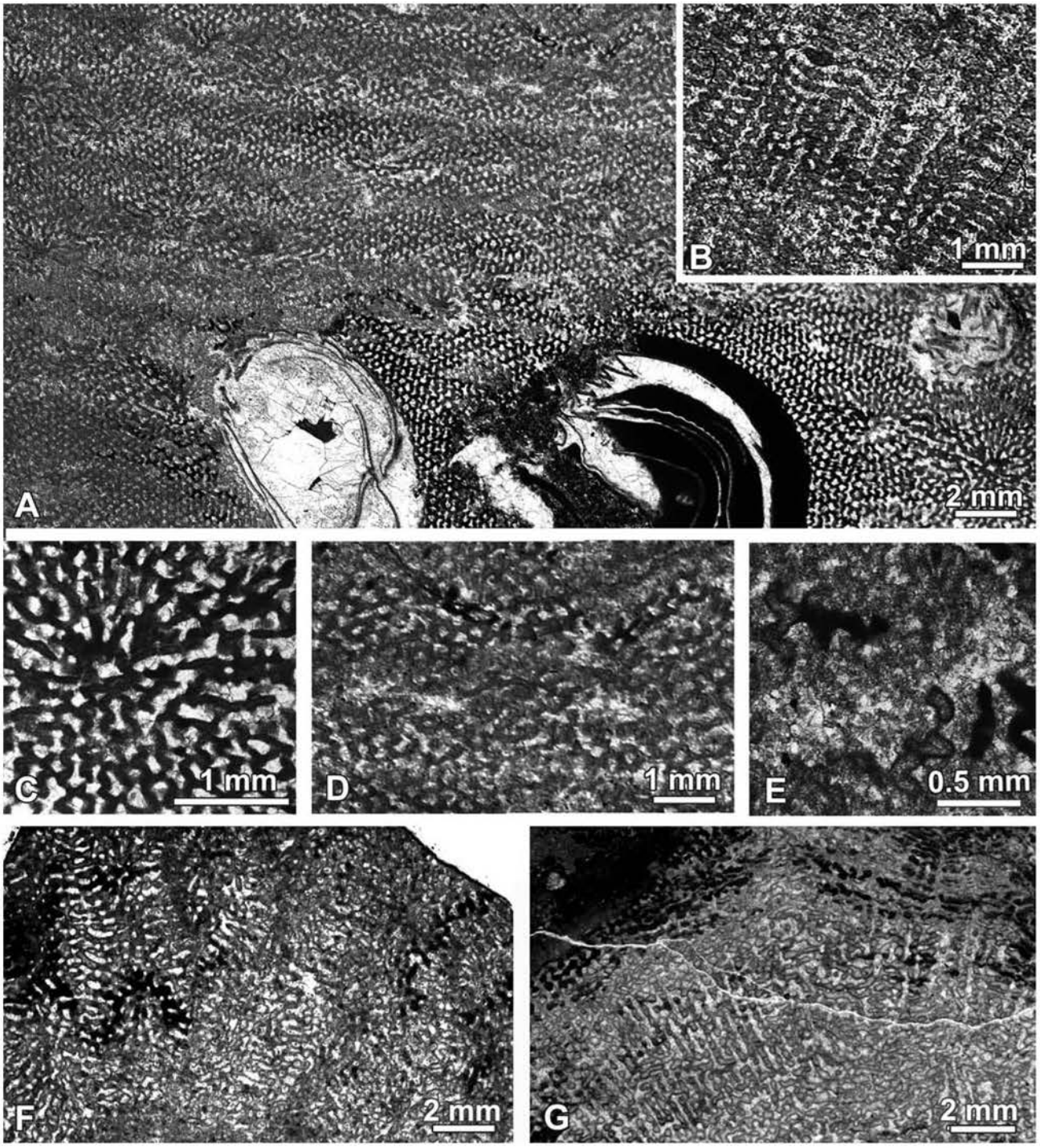

Fig. 19. **A–D** – *Comoseris* sp.: A – transverse thin section (No. 45a) of colony fragment showing corallites arranged in straight, mainly monolinear narrow series, only in places varying in width; B – longitudinal thin section (No. 45b) presenting pennular radial elements and the course of the menianes; C – detail from Fig. A, note a small columella and presence of a valley septum; D – enlarged corallite series from Fig. A. **E** – fragment of septo-synapticular wall occurring in places between series (thin section No. 45A). **F, G** – *Comoseris* cf. *interrupta* Koby: F – transverse thin section (No. 31/2a) of peripheral colony part with short corallite series arranged subradially; G – longitudinal thin section (No. 31/2b) presenting regular porous radial elements

lenidae family, but assigning it to a particular genus encounters difficulties. It could be *Microsolena* Lamouroux with corallites arranged in series. It could also be included with reservation in the genus *Meandrarea* Etallon on account of the collines occurring between series. In this paper, it has been decided to place it only in the familiar range.

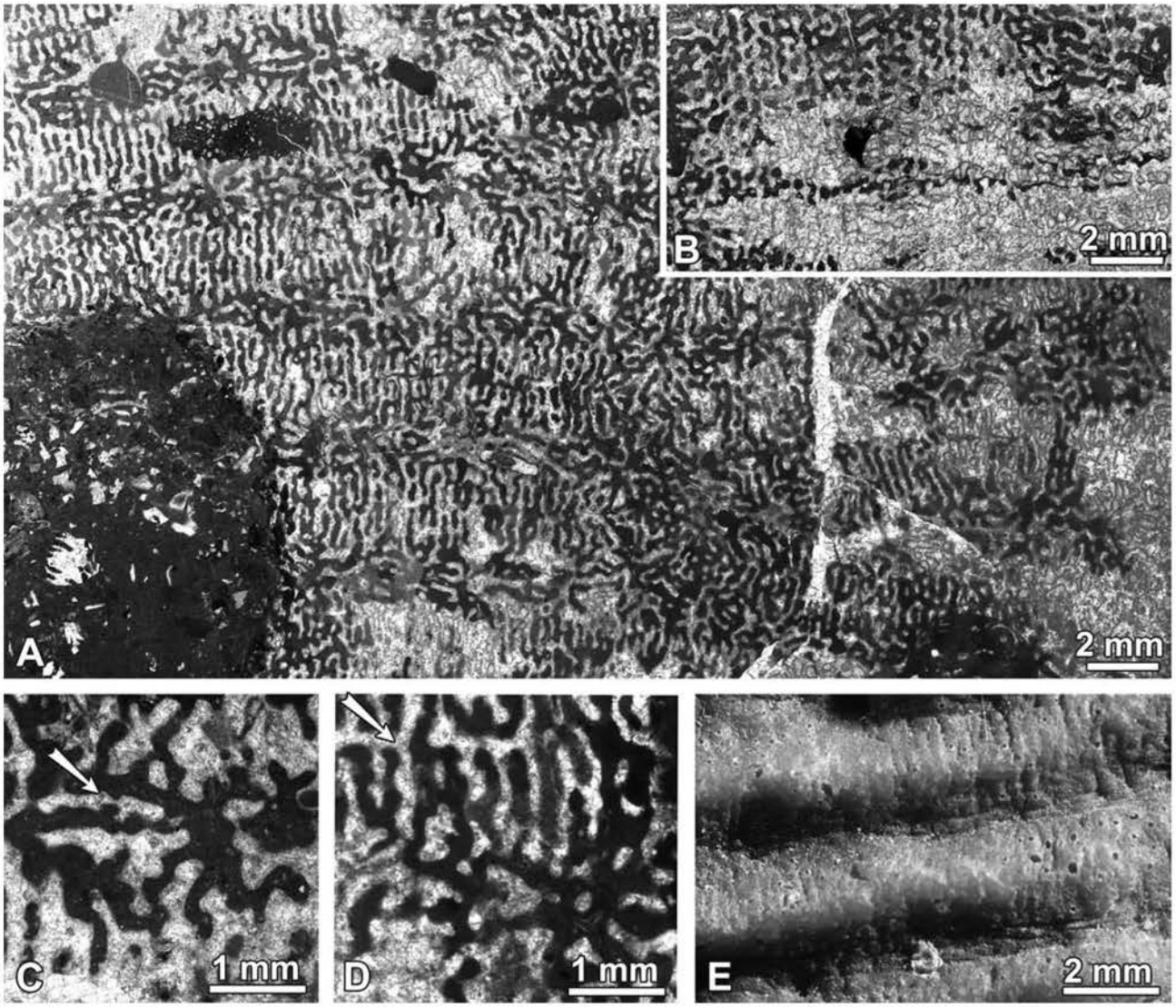

Fig. 20. **A–E** – *Meandrarea gresslyi* Etallon, *sensu* Koby: A – transverse thin section (No. 5a) of colony fragment showing slightly subconcentric corallite series; B – longitudinal thin section (No. 5b) showing pennular, porous radial elements and in places pennules coalescing into menianes; C, D – enlarged fragments from Fig. A presenting: C – valley-like septa (arrow), and D – rudimentary synapticular wall (arrow) between series and small monotrabecular columella. Note also radial elements subequal in thickness; E – *Meandrarea gresslyi* Etallon presented in Koby, 1888, pl. 109, fig. 1 (coll. Koby, hypotypoid No. D4853). Fragment of the upper colony surface to show corallite series with subdistinct, densely arranged calices. Valley-like septum forms are observed in places. Photo of the upper colony surface was taken in 1988 with permission of the Authorities of the Museum of Natural History in Basel

Family LATOMEANDRIDAE Alloiteau, 1952, emend. Morycowa et Roniewicz, 1995
Genus *Epistreptophyllum* Milaschewitsch, 1876
Type-species: *Epistreptophyllum commune* Milaschewitsch, 1876

Epistreptophyllum sp.
Fig. 22F, G

Material and measurements (in mm):
(In sample No. 33, *Epistreptophyllum* sp. together with *Rhipidogyra* sp. occur).

Well name	Depth in metres	Specimen and thin section numbers	D	den s	den c
Dąbrówki Breńskie 1	602.0–09.3, I	33 (33a, b)	10×17	ca. 80	3–5/2

Remarks: Solitary corallum examined in cross sections only. Radial elements alternating in thickness, subcompact, with rare pores in their inner margins. Lateral septal faces with irregularly distributed granules and pennula-like forms (Fig. 22G). Costae thick, subequal. Columella parietal. Wall recrystallized, perhaps synapticular.

The coral examined herein macroscopically resembles solitary corals from the genera *Epistreptophyllum* Milaschewitsch (see also Pandey & Lathulière, 1997) and *Epistreptum* Roniewicz (Roniewicz, 2008), which generally differ from each other in septal micromorphology. On account of this feature, *i.e.* granular together with pennular-like septal face micromorphology (not with pointed granules), the specimen from the Carpathian Foreland is placed in the genus *Epistreptophyllum*. Insufficient corallite preservation does not allow a more precise identification.

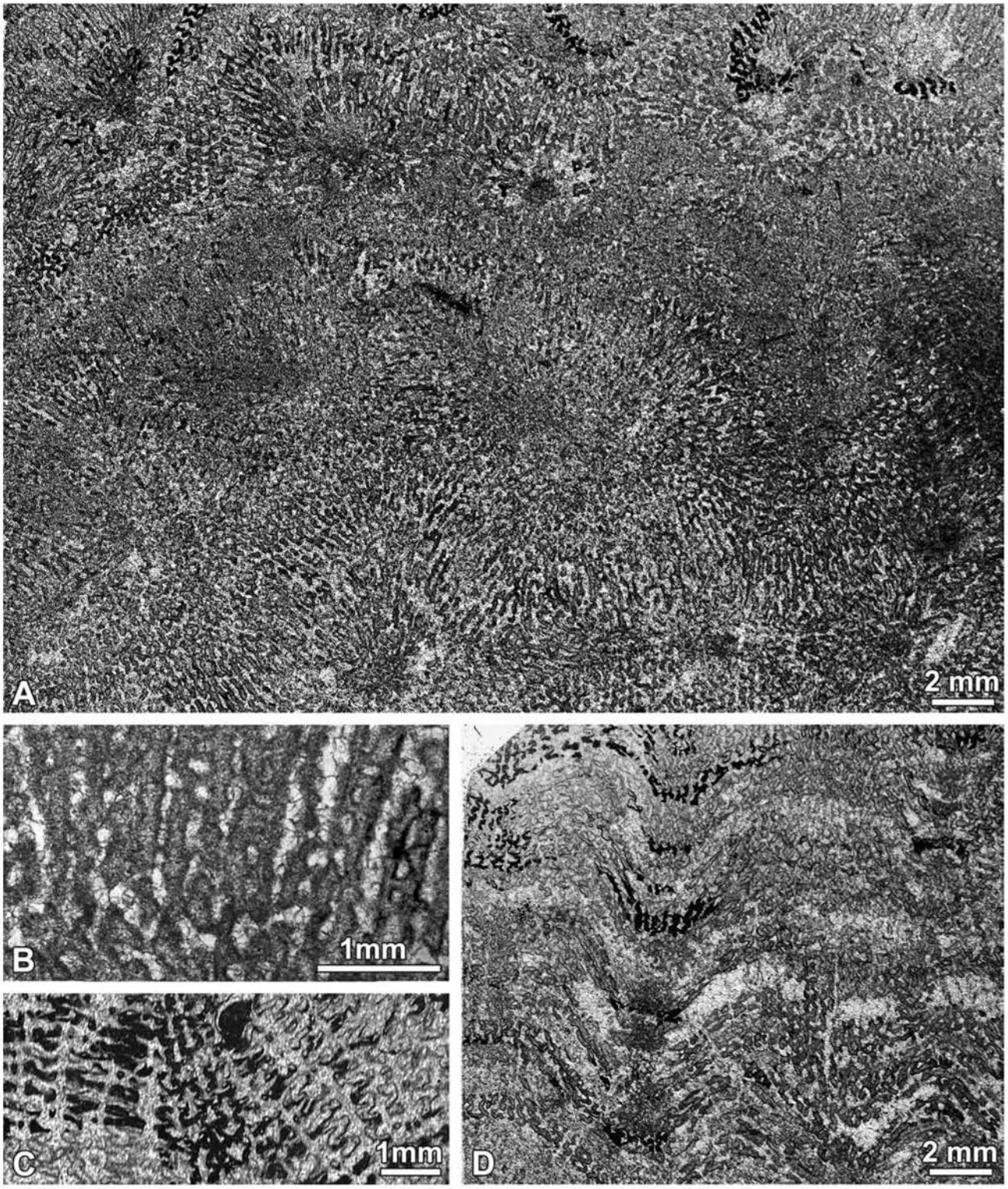

Fig. 21. **A–D** – Microsolenidae indet.: A – transverse thin section (No. 30/2a) of colony with corallites arranged in series; B – enlarged fragment of Fig. A showing type of septal porosity; C – longitudinal-tangential section (thin section No. 30/2b) of corallite showing arrangement of menianes; D – longitudinal thin section of two adjacent series showing characteristic sinusoidal arrangement of menianes and dissepiments, concave in series and convex in collines

Genus *Latomeandra* Milne Edwards et Haime, 1848
Type-species: *Lithodendron plicatum* Goldfuss, 1827

Latomeandra ramosa (Koby, 1884)
Fig. 22A–E

1884. *Calamophyllia flabellum* Blainville var. *ramosa*: Koby, p. 184, pl. 53, fig. 3.
1964. *Latomeandra delemontana* (Koby): Beauvais, p. 246, pl. 32, fig. 5.
1976. *Latomeandra ramosa* (Koby): Roniewicz, p. 96, pl. 27, figs 4, 5.

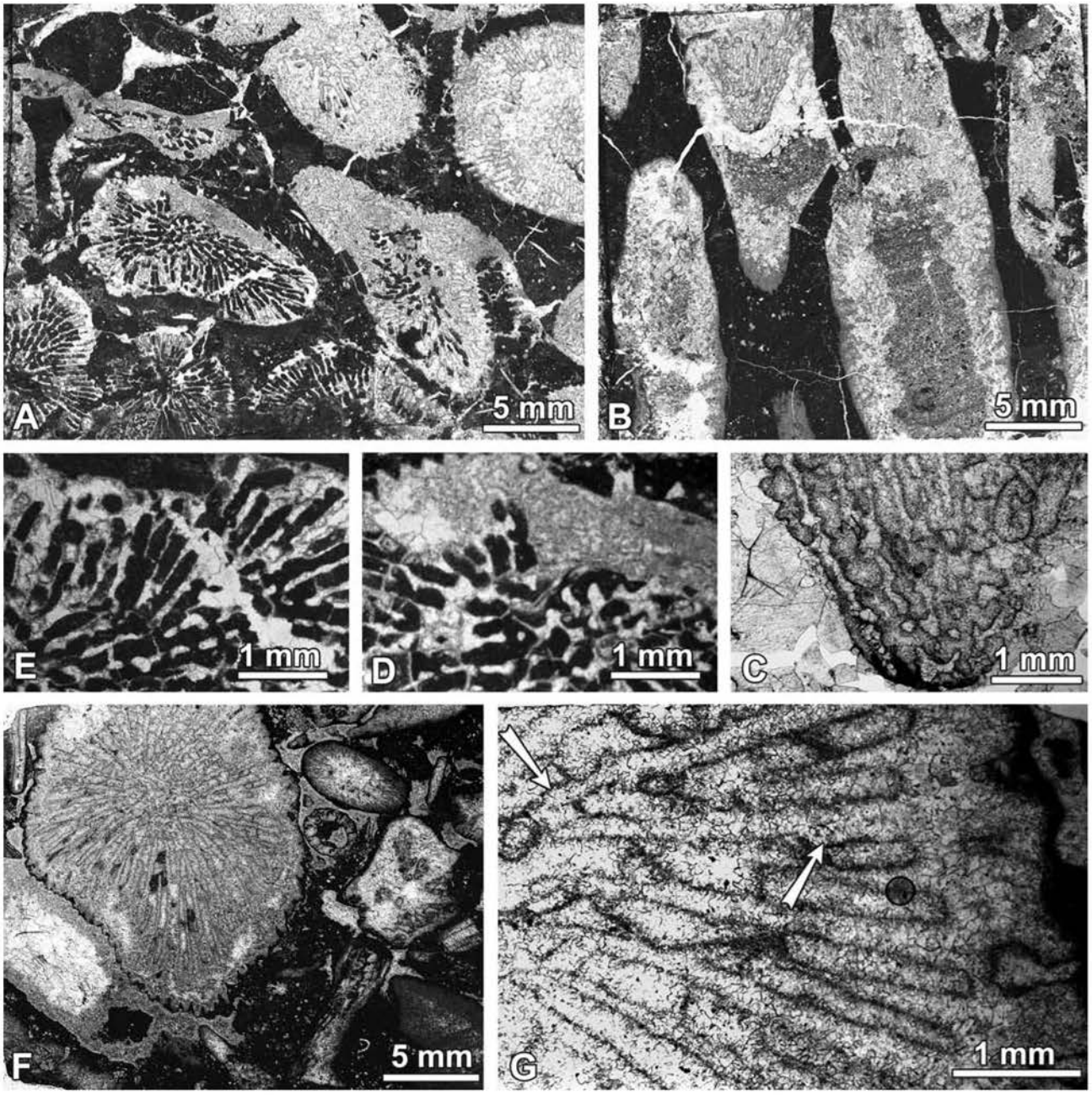

Fig. 22. **A–E** – *Latomeandra ramosa* (Koby): A – fragment of phaceloidal colony in transverse thin section (No. 23/2a); B – longitudinal thin section (No. 23/2b) of not well preserved corallite branches. Traces of large, slightly concave endothecal elements are visible; C – detail of the corallite from Fig. B; D, E – enlarged fragments of corallite from Fig. A showing porosity and anastomosis of septa. **F, G** – *Epistreptophyllum* sp.: F – transverse thin section (No. 33a) of solitary corallite with thin, numerous radial elements; G – enlarged fragment of Fig. F showing granules and some pennula-like forms in lateral septal section (arrows)

2008. *Latomeandra ramosa* (Koby): Roniewicz, p. 120, fig. 13d.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	H	d	cor-cor	S	den c
Dąbrowa Tarnowska 1	807.3–813.3, II	23/2 (23/2a–c)	*ca.* 70	4.5–8×5.5–10	1–3(6)	60–*ca.* 100 (S1-S4+nS5)	7–9/2

Remarks: Corallum phaceloid. Corallites in cross sections oval, circular and irregular during the budding process. Septa thin, subequal in thickness, often anastomosing, differentiated generally into 4 size orders. Pennules and menianes in longitudinal section 3 per 1 mm. Columella parietal. Endotheca composed of extended dissepiments. Budding intracalicular, with lamellar linkages.

Beauvais (1964) included *Calamophyllia flabellum* Blainville var. *ramosa* Koby (collection Koby) in the genus *Latomeandra*, in the synonyms of *Latomeandra delemontana* (Koby). Roniewicz (1976, 2008) described *C. flabellum* Blainville var. *ramosa* Koby under the name *Latomeandra ramosa* (Koby), including here the synonyms *L. delemontana* (Koby) described by Beauvais (1964), as well as ?*Latomeandra fromenteli* (Koby) described by Errenst (1991). The measurements of all taxa mentioned above (Table 5) are generally comparable, which indicates that they may represent

Table 5

Comparison of species placed herein to the synonymy of *Latomeandra ramosa* (Koby, 1884)

Species	d	S	den s/2	Authors	Occurrence
Latomeandra delemontana (Koby)	3–10		7–10	L. Beauvais, 1964	Switzerland and France: Middle-Upper Oxfordian
Latomeandra ramosa (Koby)	d: 5–7 D: 6–10	70–98	8–9	Roniewicz, 1976	Romania: Upper Oxfordian
Latomeandra fromenteli (Koby)	monocentric:3.5–7.5 polycenric: 11–15	>70	*ca.* 9	Errenst, 1991	Spain: Kimmeridgian
Latomeandra ramosa (Koby)	6–11	55–100	9	Roniewicz, 2008	Bulgaria: Valangnian
Latomeandra ramosa (Koby)	4.5–8×5.5–10	60–*ca.* 100	7–9	here assigned to L. ramosa (Koby).	Polish Carpathian Foreland: Tithonian

the same species. In this paper, the name of the species from the Carpathian Foreland is given after Roniewicz (1976) as *Latomeandra ramosa* (Koby, 1884).

Distribution: Middle–Upper Oxfordian of Switzerland, France. Upper Oxfordian of Romania. Valanginian of Bulgaria.

?Latomeandra sp.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	H	D	den s
Dąbrowa Tarnowska 1	783.3–786.7, I	22/2 (22/2a, b)	*ca.* 40	suboval: 6–8 elongate to 12	*ca.* 8/2

Remarks: Poorly preserved phaceloid corallum, recrystallized within the interior corallite zone. The corallites circular, oval and irregular in outline. The radial elements are preserved only on the wall internal surface. The specimen is classified here with reservation to the genus *Latomeandra*.

Genus *Fungiastraea* Alloiteau, 1952
Type-species: *Fungiastraea laganum* Alloiteau, 1952

Fungiastraea subtilis Eliašova et Roniewicz, 1990
Fig. 23A, B

1990. *Fungiastraea subtilis* Eliašova et Roniewicz: Eliášová, pp. 124–125, pl 3, fig. 2.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	c-c in series	c-c between series	den s	S
Dąbrówki Breńskie 1	702.0–708.6, I	35/2 (35/2a, b)	2.5–4.5	4.0–7.5 (9)	9–10/2	30–50 (60)
Smęgorzów 2	639.0–645.8, VI	44/2 (44/2a)	3.0–4.5	3.5–6.5	8–10/2	32–50

Remarks: The corals correspond to *F. subtilis* Eliášová et Roniewicz (Eliášová, 1990) in corallite diameters, in partly being arranged in series, thin radial elements and their density but differs from it in slightly more numerous radial elements.

Distribution: Lower Kimmeridgian of Romania. Upper Jurassic–Lower Cretaceous of the Czech Outer Carpathians.

Fungiastraea aff. *subtilis* Eliášová et Roniewicz, 1990
Fig. 23E–G

1990. *Fungiastraea subtilis* Eliášová et Roniewicz: Eliášová, pp. 124–125, pl 3, fig. 2.

Material and measurements (in mm):

Well name	Depth in metres	Specimen and thin section numbers	c-c in series	c-c between series	den s	S
Dąbrówki Breńskie 1	702.0–708.6, I	35/3 (35/3a)	2.5–4.0	3.5–6.5	7 (8)/2	32–*ca.* 50

Remarks: The specimen in corallite parameters comparable to *F. subtilis* Eliášová et Roniewicz but differs from it in having less dense radial elements.

Genus *Protoseris* Milne-Ewards et Haime, 1851
Protoseris waltoni Milne-Ewards et Haime, 1851

Protoseris sp.
Fig. 23C, D

Material and measurements (in mm):
(In sample No. 16/1, *Protoseris* sp. occurs together with *Microsolena exigua*).

Well name	Depth in metres	Specimen and thin section numbers	D; H fragm	c-c	den s	S
Swarzów 3	738.3–743.9, IV	15/2 (15/2a)	7–17×25	5.0–6.5	9/2	*ca.* 20–40
Swarzów 3	765.2–770.2, I	16/1 (16/1a–c)	18× *ca.* 30	6.0–8.0 (8.5)	4–6/2	30–*ca.* 60

Remarks: Fragments of foliaceous plates, often irregular in outline, of the latomeandrid coral of the genus *Protoseris* Milne-Ewards et Haime. In the characteristic features, *i.e.* the shape of plate, diameter and arrangement of corallites as well as the number of radial elements, the coral approaches *Protoseris robusta* Becker is known from the Upper Kimmeridgian of Germany (Becker & Milaschewitsch, 1875–1876, pl. 42, fig. 2a, b; 3a, b; compare also Geyer, 1954) and Tithonian of Czechia and Poland (Ogilvie, 1897; Geyer, 1955a). It is also similar to *Protoseris* cf. *robusta* from the Lower Kimmeridgian of Romania and Valanginian of Bulgaria (*cf.* Roniewicz, 2008).

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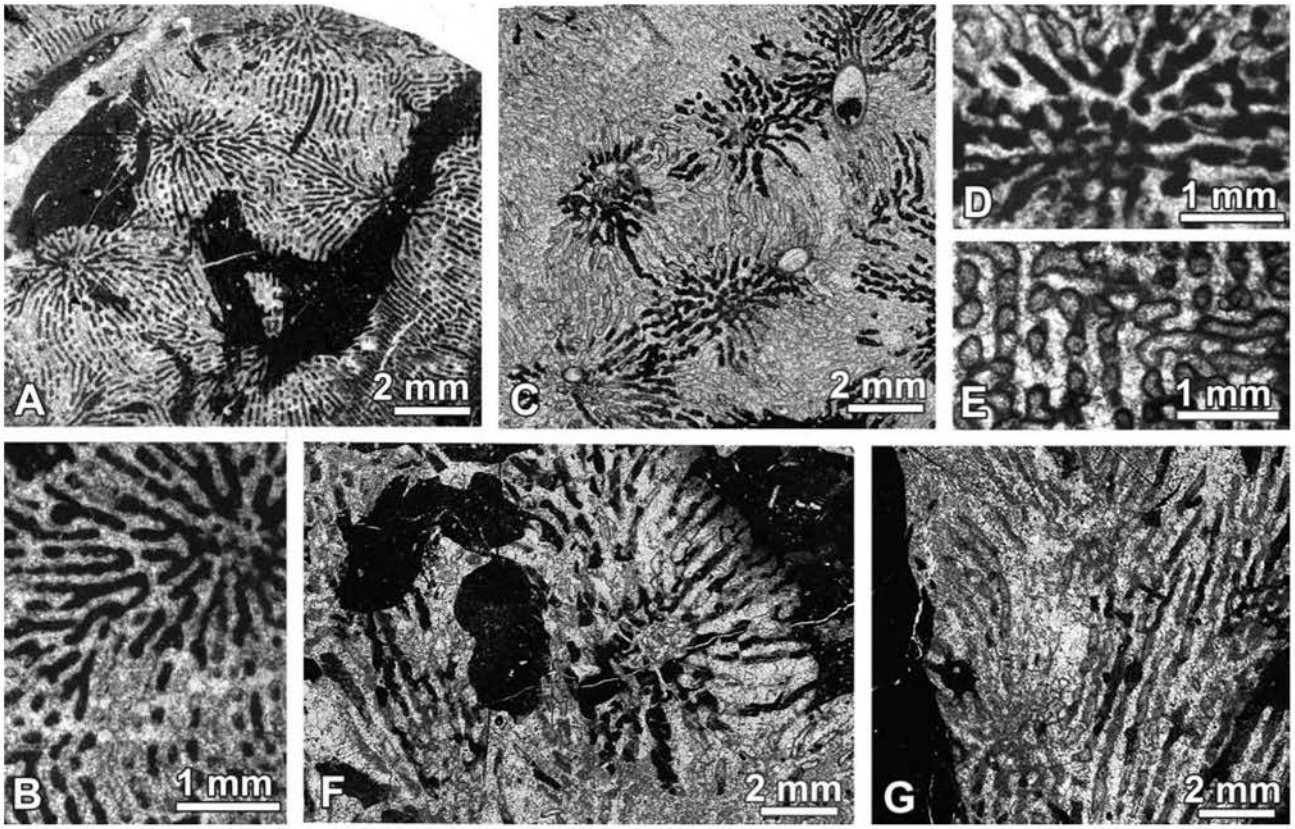

Fig. 23. **A, B** – *Fungiastraea subtilis* Eliášová et Roniewicz: A – transverse thin section (No. 35/2a) of partly preserved colony; B – enlarged fragment of Fig. A showing thin, subequal in thickness, radial elements characteristic of this species. **C–E** – *Fungiastraea* aff. *subtilis* Eliášová et Roniewicz: C – thin section of colony fragment (No. 35/3a) to show corallites arranged in parallel series; D – detail from Fig. C presenting central zone of corallite with large papillose columella; E – longitudinal section (No 35/3b) showing short, prominent menianes. **F, G** – *Protoseris* sp.: F – section across the fragment of the plate (thin section No. 16/1) presenting corallites with radial elements of three size orders and papillose columella; G – side view of subdendroid colony; part of corallite series is well-marked

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